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(BAW—10074A(Rev.1))
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Volume 2, Number 22, November 30, 1977

ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 54649, 54688, 54690, 54873

53603 Bibliography and index of U.S Geological Survey publications relating to coal, January 1971—June 1974. Walker, F.K. Washington, DC; Geological Survey (1975). 18p.

This bibliography and index contains about 200 reports and maps relating to coal published by the U.S. Geological Survey in the 3 1/2-year period, January 1971 through June 1974. It is supplementary to Geological Survey Publications Relating to Coal, 1882-1970.

53604 Review of Wyoming coal fields, 1976. Glass, G.B. Laramie, WY; Geological Survey of Wyoming (1976). 25p. (NP—22155).

After identifying coal-bearing areas and coal-bearing rocks of Wyoming, structural geology of the coal deposits is discussed; the coal is then characterized. Coking coal and coking operations, in-situ gasification, and coal mining and production in Wyoming are reviewed. Location, characteristics, reserves and mining activities are given for Powder River Coal Basin, Green River Coal Region, Hanna Coal Field, Hams Fork Coal Region, Bighorn Coal Basin, Wind River Coal Basin, Jackson Hole Coal Field, Blacks Hill Coal Region, Rock Creek Coal Field and Goshen Hole Coal Field. Total coal resources, production, reserves and land reclamation data are included. 33 references. (MCW)

PROCESSING

REFER ALSO TO CITATION(S) 53972

53605 (ORNL—5282) **Coal technology program. Quarterly progress report for the period ending March 31, 1977.** (Oak Ridge National Lab., Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 192p. Dep. NTIS, PC A09/MF A01.

Two-dimensional pyrolysis behavior of an eastern bituminous coal has been studied using slow heating rates and maximum temperatures ranging from 600 to 1000°C. Significant swelling has been observed, especially at lower heating rates, and gas production has been erratic. Chars produced have been singularly unreactive and possess considerable crushing strength, in direct contrast with those obtained from western subbituminous coals which were pyrophoric and extremely friable. All process equipment and instrumentation for investigation of the pressurized carbonization of Consol synthetic fuel residue has been installed and four experimental shakedown runs have been made. Tests on the gas-fired potassium boiler using water as a stand-in for potassium have been completed. We are conducting a design study of a coal-fired alkali metal topping cycle and conventional steam bottoming cycle to establish a reference design for a 200-MW(e) utility module. We completed the compilation of physical and thermodynamic properties of cesium and potassium, the analysis of a series of cesium and potassium turbine designs, and the determination of the cycle efficiency for both fluids for a variety of operating conditions. Several activities are in progress for nondestructive examination of wear- and process-resistant coatings. A new x-ray fluorescence system has been installed. Radiography has proved useful in monitoring the condition of tensile-cracked surface-defect specimens at various stages in the cracking process. Thermal testing has successfully detected unbonds in ZrO_2-coated specimens. Calibration continues on the eddy-current instrument to measure ceramic coating thickness. Useful results with a new and unusual liquid penetrant formulation were demonstrated. The deposition of alloy 320 cladding on low-alloy steels has been studied experimentally using the gas metal-arc and submerged-arc processes. (LTN)

53606 Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975). 228p. (CONF-750306—). .

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

Papers and abstracts of papers presented at the meeting are included. Separate abstracts were prepared for 15 papers. (MCG)

53607 Reactivity of heat-treated coals in hydrogen. Tomita, A.; Mahajan, O.P.; Walker, P.L. Jr. (Pa State Univ, University Park). *Fuel;* 56: No. 2, 137-144(Apr 1977).

Reactivities of eighteen 40-100 mesh U.S. coals charred to 1000°C have been measured in H_2at 2.7 MPa and 980°C. The char–hydrogen reaction usually occurs in two stages: a slow induction period followed by a constant-rate region. Reactivities of chars in H_2 differ markedly from those in air and CO_2. Results of surface-area measurements of chars and activation energies for the hydrogasification reaction suggest that during the induction period the reaction is diffusion-controlled whereas in the constant-rate region it is chemically controlled. Removal of mineral matter from coals prior to their carbonization brings about profound changes in surface area and porosity of chars. The effect of char particle size on reactivity is considered. 24 refs.

CARBONIZATION

REFER ALSO TO CITATION(S) 53672, 53810

53608 (CONF-7505139—, pp 63-83) **Relationship between cokability and petrographic composition of agglomerating coals.** Thompson, R.; Benedict, L.G. (Bethlehem Steel Corp., PA). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

The term agglomeration refers to the ability of a coal to be transformed into a cohesive coke structure when heated under reducing conditions. Prior to the development of the petrographic analytical application described, the agglomeration test and the related Free Swelling Index (FSI) test had been developed to identify those coals that will agglomerate and to provide a scale for rating such coals in terms of the agglomerating ability and hence their cokability. These tests were an attempt to classify coals of different composition on the basis of their ability to coke. In the steel industry, the petrographic, or microscopic, analysis has supplanted the agglomeration and FSI tests as a means of relating the composition of coals to cokability. The petrographic analysis is an advance over those earlier tests, because it recognizes the fact that coal is a heterogeneous mixture of organic constitutents that react differenty in the coking process. Therefore, coke is a result of the combined reactions of the many constituents in the coal or coal mix. Over the years, much has been learned about the reaction of the different constituents in coal, and correlation systems have been developed from which coking properties can be predicted from a coal petrographic analysis. These findings together with applications are illustrated in the present paper. Finally, applications to other processes, such as the conversion of coal to liquids and gases, are suggested.

53609 Use of non-caking and low-caking carbon-bearing materials for the manufacture of lump cokes. Flasche, K.H.; Gross, R.; Keller, H.; Lask, G.W.; Leibrock, K.; Petak, H.; Ruebel, K. *Stahl Eisen;* 97: No. 6, 281-285(Mar 1977). (In German).

The raw material situation in the coal district on the Saar; calculation diagram to determine material costs in the coking plant;

material and technological possibilities to manufacture blast furnace coke from caking, high-volatile coals; dependence of the coke quality on the heating flue temperature; leaning with the aid of petroleum coke; and results of tests in the semi technical plant using the top charging and stamping methods and different leaning materials are reported.

53610 Production of formed coke in conventional coking chambers. Wenzel, W.; Gudenau, H.W.; Bernt, J. *Stahl Eisen;* **97**: No. 6, 286-290(Mar 1977). (In German).

Pelletizing of fine-ground coal and coating with shells of ore or lime; means to increase the green strength of the pellets; charging the coal pellets into conventional horizontal chamber furnaces; manufacture of coke of uniform size with reduced coking period; possibility of using charging coals with a wide range of different contents of volatile matters; and comparison with the properties of the usual blast furnace lump coke are presented.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 53649, 53655, 53810

HYDROGENATION

REFER ALSO TO CITATION(S) 53642, 53647, 53648, 53652, 53660, 53661, 53662

53611 (FE—2010-08) **Characterization of coal liquids. Intermediate report. Hydrocracking upgraded Solvent Refined Coal (SRC).** deRosset, A.J.; Tan, G. (UOP, Inc., Des Plaines, Ill. (USA)). Nov 1976. Contract EX-76-C-01-2010. 10p. Dep. NTIS, PC A02/MF A01.

In the hydrotreating processability study of Solvent Refined Coal (SRC) in addition to studying the effects of various variables, a preparative hydrotreating run was made to produce 4.5-gallons of upgraded SRC for use as feedstock in a hydrocracking study. This charge stock serves as the last of eight ERDA coal liquids to be characterized as to processability by conventional petroleum refining technology. The upgraded SRC, containing 9.8 percent C_7-insolubles and 70.1 percent 650°F$^+$ bottoms, was processed over a commercial hydrocracking catalyst at four sets of conditions, including a catalyst activity check at startup conditions at the conclusion of the run. At base space velocity, 10°C above base temperature, and 200 psig above base pressure, conversion, defined as percentage disappearance of 650°F$^+$ bottoms, was only 11.8 percent. This low yield of 650°F$^-$ distillate is attributed to the presence of high molecular weight asphaltic materials.

GASIFICATION

REFER ALSO TO CITATION(S) 53653, 53659, 53665, 53666, 53686, 53710, 53711, 53715, 54223, 54441, 54713, 54714

53612 (CONF-7505139—, pp 163-174) **Control of agglomeration in coal hydrogasification.** Mason, D.M. (Inst. of Gas Tech., Chicago). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

A fluidized-bed process for pretreating bituminous coal to reduce or destroy its agglomerating property has been developed for use in the HYGAS Process for the production of substitute natural gas. Devolatilization and mild surface oxidation occur by reaction with air or diluted air at atmospheric pressure and at temperatures from about 700 to 850°F. Conditions have been established over a wide range of coal ranks for a minimum loss of volatile matter compatible with the satisfactory behavior of the coal in a process development unit. The effects of pretreatment on particle structure and on subsequent hydrogasification reactions have been studied by observation of petrographic and related properties.

53613 (CONF-7505139—, pp 195-203) **Behavior of caking coals in fixed-bed gasifiers.** Gillmore, D.W.; Coates, N.H. (Morgantown Energy Research Center, WV). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

Gasification of coal with air and steam produces a low-Btu fuel gas (130-170 Btu/scf) suitable for firing industrial furnaces, powerplant boilers, or combined gas-steam turbine cycles. However, commercial fixed-bed gasifiers currently available can use only closely sized, non-agglomerating coals. The Morgantown Energy Research Center has developed a stirred, fixed-bed gasifier that will process strongly caking coals, including the fine sizes. This paper describes this 42-in.-dia. gasifier that has been developed and discusses operations with Appalachian coals.

53614 (CONF-7505139—, pp 215-221) **Agglomeration as a factor in the design of low Btu-gasification systems.** Galli, A.F. Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

The agglomerating properties of some coals require added steps or more complex processing in their conversion to low Btu gas. Since all processes for the conversion of coal to low Btu gas operate at temperature above the coal agglomeration temperature range, the coal must at some stage during its processing pass through the agglomerating phase to cause operating problems and therefore, special techniques must be used in order to minimize its deleterious effect on the process. The agglomerating properties must be removed with minimum effect on the operation of the process. The methods of destroying the agglomerating properties of caking coal are: pyrolysis, oxidation, and hydrogen treatment.

53615 (CONF-7505139—, pp 187-193) **Gasification of agglomerating coal to high-Btu gas.** Feldmann, H. (Battelle Columbus Labs., Columbus). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

Though eastern coals have very significant advantages over western coals for conversion to SNG, a major barrier to their utilization is their tendency to severely agglomerate a gasification condition. The severity of the problem has resulted in several approaches to allow these important resources to be handled in gasification systems for producing high-Btu gas. These approaches utilize the following means of avoiding agglomeration: mechanical stirring; oxidative pretreatment; entrained reactor system; dilute free-fall reactor system; utilization of an ash diluent; non-oxidative chemical pretreatment; and molten salt systems. These techniques and their process implications are described.

53616 Status of ERDA demonstration plant program. Rial, G.A. pp 134-144 of In Proceedings of s symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

US ERDA's program is to demonstrate, at a near commercial scale, promising coal and shale processes that have been developed and evaluated in industry and government R and D programs and to encourage industry participation by providing partial funding to minimize the risk. The processes under consideration are the so-called second-generation processes that have been tested on a pilot-plant basis. The present policy is for the government to fund all the conceptual design activities and share 50-50 in the detailed design, procurement, construction, and operation. The basis and objectives of the program are outlined in some detail. Initial projects will involve Clean Boiler Fuel; High Btu Pipeline Gas and Low Btu Fuel Gas. The status of these projects is reviewed briefly. Other projects under consideration are Advanced Liquefaction; Fluidized-bed combustion and Shale Oil. (LTN)

53617 (FE—1513-60) **Agglomerating burner gasification process: design, installation, and operation of a 25-ton-a-day process development unit. Monthly progress report for May 1977.** (Battelle Columbus Labs., Ohio (USA)). 17 Jun 1977. Contract EX-76-C-01-1513. 13p. Dep. NTIS, PC A02/MF A01.

This monthly report summarizes progress on the operation of the 25-ton-a-day coal gasification PDU to study the Agglomerating Burner Gasification Process. Also reported is work on the process engineering task and the activity on the turbine engineering study. Tests during the month established that, at least in the absence of solids circulation, the present burner design can be operated at superficial bed velocities up to 6 ft/sec without excessive carryover of bed material into the cyclone. This month, for the first time, the integrated burner/gasifier system was operated with hot solids circulation and with the system temperatures maintained for an extended period solely by the burning of coal.

53618 (FE—1770-23) **Computer modeling of coal gasification reactors. Quarterly technical progress report, October 1, 1976—December 31, 1976.** Blake, T.R. (Systems, Science and Software, La Jolla, Calif. (USA)). Feb 1977. Contract EX-76-C-01-1770. 90p. (SSS-R—77-3145). Dep. NTIS, PC A05/MF A01.

This was the second quarter in the second year of research to develop and apply computer codes, based upon continuum theories of multiphase flows, to the performance of fluidized bed and en-

trained flow coal gasification reactors. Research was active in several areas. The research on the fluidized bed computer code included the development of the models for the heterogeneous and homogeneous reactions appropriate to char combustion and the incorporation of that chemistry into source and transport terms for the conservation equations. These source terms will be included in the numerical model in the next quarter. The basic numerical code was modified to reduce computer core requirements and to thereby permit the calculation of problems with a large number of zones. Parametric calculations were performed with this code to represent the influences of bed geometry, mass flow rate and distribution and hydrostatic pressure effects in fluidized beds. The work on the entrained flow computer model involved both the formulation of the basic conservation equations and the development of a computer code to test possible numerical techniques appropriate for that system of conservation equations. These conservation equations represent turbulent compressible flow of gas and solid particles, including the influence of chemical reactions. Constitutive equations for these turbulent flows are being formulated. The computer code is a finite element-finite difference code which treats a system of equations mathematically like that for entrained flow and it is being used to investigate the application of finite element techniques to the computer modeling of such flows.

53619 (FE—1775-7) **Fischer—Tropsch complex conceptual design/economic analysis: oil and SNG production. R and D report No. 114, interim report No. 3.** O'Hara, J.B.; Bela, A.; Jentz, N.E.; Khaderi, S.K.; Klumpe, H.W.; Loran, B.I.; Reynolds, D.G.; Teeple, R.V. (Parsons (Ralph M.) Co., Pasadena, Calif. (USA)). Jan 1977. Contract EX-76-C-01-1775. 339p. Dep. NTIS, PC A15/MF A01.

Results are described of a conceptual design and economic evaluation for a conceptual Fischer-Tropsch plant responsive to U.S. demands and economic requirements. A primary objective of this conceptual design is to define the characteristics and projected economics of a commercial coal mining and conversion complex to be constructed and operated in the 1980's and 1990's. Key target characteristics of the design include: large size, simplicity, and reliability; energy efficiency; where justified, incorporation of advanced concepts now in development to achieve stated objectives; and definition of incentives for further development work required to convert the concepts to reality. Fischer-Tropsch technology provides potential for broad product flexibility. A range of product spectrums can be produced by proper selection of catalyst, reactor configuration, and operating conditions such as feed gas composition, temperature, pressure, and space velocity. It is important to recognize that the design presented here represents only one of a large number that can be developed to exploit Fischer-Tropsch technology.

53620 (FE—1775-8) **Oil/gas complex conceptual design/economic analysis: oil and SNG production. R and D report No. 114, interim report No. 4.** O'Hara, J.B.; Hervey, G.H.; Fass, S.M.; Jentz, N.E.; Klumpe, H.W.; Loran, B.I.; Mills, E.A.; Teeple, R.V. (Parsons (Ralph M.) Co., Pasadena, Calif. (USA)). Mar 1977. Contract EX-76-C-01-1775. 320p. Dep. NTIS, PC A14/MF A01.

Results are presented of a conceptual design and economic evaluation for a commercial complex to mine high-sulfur coal and produce substitute natural gas (SNG), fuel oil, naphtha, and liquefied petroleum gases (LPG) using hydroliquefaction technology for the coal conversion portion of the complex. The design uses the solvent refined coal (SRC) hydroliquefaction and entrained slagging gasification programs, with adaptation to the specific Oil/Gas objectives. Pseudo catalytic SRC II hydroliquefaction techniques are used in which a portion of the hydroliquefier effluent is recycled to the hydroliquefier reactor to provide a higher content of ash constituents, longer reaction time, and greater hydrogen consumption to produce products that are primarily gases and liquids at ambient conditions. The design basis was developed in cooperation with ERDA. Process flowsheets and heat and material balances are presented.

53621 (FE—2213-5) **Fluid bed char gasifier: process design.** Crawford, C.L. (TRW Systems Group, McLean, Va. (USA)). 2 Dec 1976. Contract EX-76-C-01-2213-021. 50p. Dep. NTIS, PC A03/MF A01.

At ERDA's request TRW has designed a Pressurized Fluid Bed Char Gasifier suitable for producing hydrogen in Coalcon's process for producing methane and liquid fuels from coal by hydrocarbonization. The principal objective of the Pressurized Fluid Bed Gasifier (PFBG) concept, in which hot char is taken directly, under system pressure, from the hydrocarbonization reactor to the gasifier, is to avoid the heat loss and work spent in alternate schemes, such as locking the char out to atmospheric pressure, cooling, grinding, and slurrying it to pump it back up to system pressure for gasification in an entrained state, slagging gasifier. However, there are other substantial benefits which are listed, and in view of the many advantages shown for direct transfer of hot char at pressure from the hydrocarbonizer to a low temperature (about 1600°F) fluid bed gasifier, these recommendations are made: Incorporate a system-pressure fluid bed gasifier into the Coalcon process; determine optimum operating temperature; after shift conversion and acid gas removal, separate the methane for sale and raise the hydrogen purity; consider the merits of gasifying the char "completely" to increase methane production; plan to operate the gasifier at a higher pressure than the hydrocarbonizer in order to eliminate the need to compress the makeup hydrogen; consider the use of coarser coal in the hydrocarbonizer in order to increase gas velocities and reduce the diameters of both hydrocarbonizer and gasifier; and obtain the experimental data needed to firm up the design.

53622 (FE—2240-67) **Quarterly technical progress report, January—March 1977.** Detman, R. (Braun (C.F.) and Co., Alhambra, Calif. (USA)). Apr 1977. Contract EX-76-C-01-2240. 23p. Dep. NTIS, PC A02/MF A01.

Progress in the acquisition of operating data at the pilot plants was very poor due to the extremely cold winter and curtailment of natural gas. The HYGAS pilot plant successfully pretreated an Illinois coal from the Peabody Number 10 Mine, but was not able to conduct a sustained run because of leaks in the gasifier. The CO_2 Acceptor plant successfully tested the modified regenerator and char lift line using air for gas lift. Attempts to run the regenerator to produce an oxidizing flue gas were thwarted by local power failure. The BI-GAS plant operated briefly with char to the higher temperature stage, but the run was terminated by a fire in the hot gas recycle heater. The Synthane plant achieved some 97 percent carbon conversion during one 24-hr period with coal feed injection directly into the fluidized bed. Process studies continued on acid gas removal, catalyst evaluation, sulfur management, methanation, and effluent treatment. Reports were forwarded to ERDA on Phenol Recovery and Plant Size. The mechanical development recommendation reports were updated and submitted to ERDA for approval. Reports on mechanical development programs investigated for subcontract award of specific hardware development and testing were all completed and forwarded to ERDA. Work was started on a standard to define minimum requirements for coal gasifier reactors. Factored estimates for second generation designs on Eastern coal were completed and forwarded to process licensors for review. A design package containing the proprietary portions of a Lurgi plant for Eastern coal along with cost estimates was received. Work was started to prepare the concept design for comparison with the second generation technology. Work continued on the Lurgi designs for lignite.

53623 (FE—2469-10) **Experimental program for the development of peat gasification. Interim report No. 2. Thermobalance studies.** (Institute of Gas Technology, Chicago, Ill. (USA)). Apr 1977. Contract EX-76-C-01-2469. 52p. Dep. NTIS, PC A04/MF A01.

The results of thermobalance tests conducted to determine the effects of temperature, pressure, and gas composition on the kinetics of peat gasification are reported. The results show that gasification rates of peat in a steam-hydrogen mixture, unlike coal, do not increase with pressure from 100 to 1000 psig. Also the poisoning effects of carbon monoxide are less than they are for coal. The gasification of peat is similar to lignite gasification and can be divided into four regimes—devolatilization, rapid-rate methane formation, and transient- and low-rate gasifications. As with coal, peat devolatilization at temperatures of 1500°F and above is almost instantaneous. The remaining non-volatile carbon is gasified in the subsequent three stages. Devolatilization of bituminous coal and peat at temperatures higher than 1300°F in the absence of hydrogen suppresses the rapid-rate methanation regime. Similar pretreatment of peat not only suppresses the rapid-rate methanation but also significantly suppresses the transient-rate gasification regime. A correlation was developed for estimating base carbon gasification rates for peat which, in conjunction with a suitable gas-solids contacting model consistent with the type of reactor system utilized, will be used to predict the residence times required to achieve desired carbon conversions. Thermobalance tests only determine the effects of operating conditions on the gasification rates of peat and do not give any information on the quantities or compositions of liquids and gases produced.

53624 (GFERC/QTR—77/2, pp 14-23) **Slagging, fixed-bed gasification.** Ellman, R.C. Jun 1977.

In Quarterly technical progress report, January—March 1977.

A pilot-scale, pressure, fixed-bed, slagging gasifier, constructed and operated in the period 1958 to 1965, has been reconditioned for further studies. The pilot plant was designed originally to establish operability of the slagging method of ash discharge and to evaluate process parameters. A major objective of the reactivated program is to utilize the pilot plant to produce liquid, solid, and gaseous effluents for study. It is planned to determine the properties and characteristics of effluents produced as a function of coal source and operating variables. These studies will aid in developing methods for maximizing the recovery of usable products, facilitating design of control technology for treatment of environmentally undesirable wastes, and aiding in achieving maximum reuse of water. The objectives of operation to date have included accumulating person-

nel operational experience, upgrading control and operating techniques, establishing the variability of operational parameters, assessing the reliability and reproducibility of sample collection techniques for the condensable effluents and the effect of operating parameters on their characteristics. When these objectives have been achieved, a control test condition for the comparative evaluation of various coals will be selected. The effect of operating pressure on gasifier results has been investigated. Gas composition was somewhat affected by increased pressure; methane and carbon dioxide contents increased at the expense of carbon monoxide and hydrogen concentrations. Other phases of operation were not appreciably affected.

53625 (NP—22188) **IITRI experiments with molten iron coal gasification.** (IIT Research Inst., Chicago, Ill. (USA)). 1976. 24p. Chicago, IL.

The bench-scale gasifier is described in detail, and photographs and drawings are included. Estimated plant operating costs are provided in tabular form. A cash flow analysis is also included.

53626 (UCRL—79114) **Calculational modeling of explosive fracture and permeability enhancement.** Butkovich, T.R.; Burton, D.E.; Bryan, J.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 May 1977. Contract W-7405-ENG-48. 11p. (CONF-770440—5; CONF-770652—2). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, Colorado, United States of America (USA) (12 Apr 1977).

With its underground explosion computer codes SOC and TENSOR, the Lawrence Livermore Laboratory is developing a capability for computer code prediction of fracture intensity and permeability enhancement far from a free face. Because the codes calculate fracture and not permeability, one must relate experimental measurements to a calculable parameter for fracture. High-explosive experiments in a coal outcrop and a multiple-charge experiment in a coal seam were designed to provide the needed data. Fracture intensity observed around the explosion centers is shown to be related to a calculated damage parameter epsilon/sub f/. This parameter is actually the total failure-induced deviatoric strain. Intrinsic permeability, determined from hydraulic conductivity and calculated from results from slug tests in wells near the explosion, correlates at least qualitatively with the calculated residual tensile-fracture porosity, π/sub f/. An important observation is that no tensile failure occurs for some distance from the explosion-formed cavity when spherical charges are employed, whereas, tensile failure occurs near the cavity wall when cylindrical charges are used.

53627 **Energy recovery from in situ coal gasification.** Fischer, D.D.; Brandenburg, C.F.; Schrider, L.A. (Laramie Energy Research Center, WY). pp 125-130 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

Estimates of the energy balance for the first underground coal gasification experiment at Hanna, Wyoming, have been calculated for a 5½-month period from mid-September 1973 through February 1974. Operating results were the most favorable during this period with dry gas production rates averaging 1.6 million standard cubic feet per day (44,800 Nm^3/day) at an average gas heating value of 126 Btu per standard cubic foot (1,122 kcal/Nm^3). The ratio of energy produced to energy consumed in running the experiment was approximately 4 and the overall efficiency was approximately 50%. Use of more efficient air compression equipment and of a system designed for combustion of low-Btu gas could increase this ratio to 8 and efficiency to 55%.

53628 **Critical parameters of in situ coal gasification.** Gregg, D.W. (Univ. of California, Livermore). pp 131-145 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

In-situ coal gasification is potentially a very attractive method for producing low- or high-BTU gas. This paper presents an outline of the Lawrence Livermore Laboratory in-situ gasification concept. In addition, a preliminary estimate of two important physical processes, coning and liquid plugging, is utilized to generate a conceptual design of a possible new approach for gasifying horizontal coal seams. Similarly, the design of a gasification system for steeply dipping coal seams is discussed, and an example of its utilization in the Soviet Union is presented.

53629 **Method of coal gasification.** Steiner, P. (to Foster Wheeler Corp., Livingston, N.J. (USA)). German(FRG) Patent 2,442,312/A/. 13 Mar 1975. 10p. (In German).

The invention is based on the discovery that the normally used pulverized coal can be gasified by the addition of water-steam and (preferably) 8-10% by volume of sulfur dioxide in the temperature range 700-760°C to an energy rich combustion gas. The sulfur hydride removed from the gas produced is transformed to a stochiometric mixture of water-steam and sulfur dioxide in an SO_2 generator. This mixture is set in the SO_2 extraction to a volumetric ratio and is returned to the coal gasification reaction. The H_2O-SO_2 ratio is adjusted according to the sulfur content of the coal.

53630 **Materials for steam gasification of coal with HTR heat.** van Heek, K.H.; Wanzl, W. (Bergbau-Forschung G.m.b.H., Essen (Germany, F.R.)); Gala, A.; Kalwa, G. (Mannesmann-Forschungsinstitut G.m.b.H., Duisburg (Germany, F.R.)). *Rev. Int. Hautes Temp. Refract.;* **13**: No. 4, 217-223(1976).

From 1. Petten colloquium on advanced high temperature material: technological and industrial aspects; Petten, Netherlands (29 - 30 Jan 1976).

The selection and development of suited metallic heat exchanger materials for coal gasification are described. The first sections of this paper give a survey over the new gasification technique and show the concept and technical realization of steam gasification with nuclear heat and, resulting from this, the main problems for research and development. The last section describes the status of the materials testing and development programs.

53631 **Commercially available clean industrial energy from coal.** Grant, A.J. (Woodall-Duckham Ltd., Pittsburgh). pp 538-544 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976).

See CONF-761016—.

By 1985, the natural gas supply in the U.S. is expected to fall short of demand by some 12 to 15 trillion cubic feet, even assuming price de-regulation. This shortfall will be borne almost entirely by major industrial users and effectively eliminates all natural gas supplies to major industries. Insutry needs to base its steam boilers and direct-fired applications on fuel systems that are readily available, meet environmental standards but are otherwise free from Governmental regulation or allocation, that are economic in operation and that allow wide flexibility in fuel purchasing. Two such commercially available fuel systems are fluidized coal-fired boilers, and industrial fuel gas from two-stage coal gasification. The Woodall-Duckham costfill and the Bbcock phototype fluidized bed combustor are described.

53632 **WESCO or ANY-CO: there must be a way.** Wooten, J.T. pp 109-123 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

The history of the WESCO project to supply substitute natural gas for use directly and to supplement natural gas supplies is given briefly. The Lurgi process was chosen in view of its commercialization elsewhere. The design was drawn up. The Federal Power Commission decided it did not have jurisdiction over the gasification plant but would have jurisdiction of the transport and sale price of the gas produced. But Wesco could not be sure of capital recovery if there were delays in construction and wanted a loan guarantee by the Federal Government. A bill proposing this passed the Senate but failed in the House. Following the FPC's rejection of jurisdiction of the gasification plant, the US Department of the Interior accepted the role of lead agency in preparing an Environmental Impact Statement. This took 32 months to complete, and a construction permit was finally issued in September, 1974. But there is evidence that the Federal EPA may change its requirements for gasification plants. Also after 3 years of negotiation the Navajo Tribal council has not yet approved a plant-site loan agreement, but may be close to doing so. In the meantime, as a result of the delay, coal supply contracts have had to be renegotiated twice. If a loan guarantee is approved ERDA will require 3 months to evaluate the project and 15 months to implement the program. (LTN)

53633 **Regulatory problems associated with coal gasification: sharing the risks.** John, F.E. pp 124-132 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

The financing problems associated with the proposed coal gasification projects in the western USA relate basically to the decision as to how the risks are to be shared between the gas consumer, between the equity sponsors of the project and between the United States taxpayers. The environmental problems relate to the dichotomy between the need for energy on the one hand and at the same time the need to protect the environment. Often this dichotomy creates what many have termed a bureaucratic maze,

duplication of effort and red tape. This duplication of effort between the Federal government and the state governments has to be ended. There are any number of ways it can be done: for example, the states and the federal agencies, at the outset, forming a task force so that one agency is not duplicating the work product of another agency which, in turn, not only delays the project and means additional capital costs, but requires an inordinate amount of manpower by the governmental agencies and consequently an increased tax burden. When an applicant has to certify a project here are just the major agencies that he has to deal with: the Federal Power Commission, the Department of Interior and its many agencies, including the Bureau of Reclamation, the Bureau of Land Management, the Bureau of Indian Affairs generally, local Indian tribes, the US Geological Survey, the US Corps of Engineers, the Secretary of the Army, federal and state environmental agencies, and State Mining Commissions. The problems of unresolved jurisdictional limits, changing rules, changing philosophy, changing personnel, etc. which represent the actual experiences of the companies and the regulatory commissions involved are enough to bring frustration or bankruptcy to strong corporations: A tragic Alice-in-Wonderland scenario too complex to be invented, but which just happened. (LTN)

53634 Where will the water come from. Rechard, P.A. pp 145-163 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

Wyoming has sufficient quantities of water available for coal gasification development. However, it is generally geographically and temporally maldistributed for easy or immediate use. To make water available at mine-mouth sites will necessitate water storage and pipelines to overcome the physical characteristics of geographic and temporal maldistribution. Of a more time-consuming nature are the institutional constraints such as water laws, interstate compacts, federal and state legislation, environmental concerns, and high costs. Some of these institutional constraints are tools whereby the Wyoming government may maintain some control over growth and development in the state. The state agencies, through the Wyoming Water Planning Program, are currently considering the many alternatives.

53635 Synthetic fuels: coal gasification in the West. West, B. pp 164-172 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

The author criticizes proposed western coal gasification plants from several points of view: Site selection (the West is short of water and the skills required, while the East has plenty of both and a large supply of coal minable by underground methods); timing (the author feels present technology is inadequate and further research may make plants built now obsolete); loan guarantees (if the proposed plants can't support their cost, they are uneconomic and should not be built); cost benefit ratio (the costs of coal gasification far outweigh potential benefits, and inflation has affected the cost of such plants unduly); and environmental impacts (the social disruption and environmental degradation in the Navajo reservation area would be disastrous due to area of land disturbed and practically impossible to revegetate, water shortages, air pollution, socio-economic factors, etc.). The abstract expresses the author's viewpoint. (LTN)

53636 Coal gasification: a gas industry viewpoint. Hunsucker, R.D. pp 175-181 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

The natural gas produced and marketed from USA domestic reserves peaked at 22.6 T cf in 1973 and declined to less than 20 T cf in 1976. Due to the extremely cold weather in early 1977, and a shortage of gas, schools were closed in many areas and industries employing several hundred thousand workers were shutdown. But if the gas supply continues to decrease, the problems could get much worse in future years. The author recommends: Incentives for exploration for natural gas, price deregulation, LNG imports, transport of Arctic gas from Alaska, and the manufacture of substitute natural gas from coal. Gas company plans for coal gasification proposed some years ago have been held up by federal and state governments. It is estimated that a total investment in the range of $14 to $20 billion will be required to produce an annual 1 T cf of substitute natural gas from coal. Environmental problems and socio-economic factors are mentioned briefly. (LTN)

53637 Technical review: catalysts for Fischer—Tropsch and isosynthesis. Shah, Y.T. (Univ. of Pittsburgh); Pettotta, A.J. *Ind. Eng. Chem., Prod. Res. Dev.;* **15**: No. 2, 123-131(Jun 1976).

A review relates the products from various catalytic systems including promoters, that may be useful in the catalytic conversion of carbon monoxide derived from coal into methane, higher hydrocarbons, alcohols, or other oxygenated species, with specific emphasis on Fischer—Tropsch synthesis and isosynthesis (to saturated branched hydrocarbons); discusses the effectiveness of iron, nickel, cobalt, and ruthenium catalysts for the Fischer-Tropsch synthesis; and evaluates some useful catalysts, e.g., potassium oxide-promoted thoria, for isosynthesis.

53638 Gasification: theory and application. Littlewood, K. (Univ. of Sheffield, Eng.). *Prog. Energy Combust. Sci.;* **3**: No. 1, 35-71(1977).

Processes for the gasification of coal, oil shales and various petroleum feedstocks are reviewed in depth: history, chemical reactions, thermodynamics, and brief descriptions of particular processes. The production of hydrogen, ammonia, methanol and other chemicals from synthesis gas are discussed. Simplified flowsheets are given in many cases. (LTN)

53639 Coal research centered on byproducts. Kershaw, R. *Glueckauf;* **113**: No. 3, 134-135(3 Feb 1977). (In German).

Activities of the National Coal Board and British Carbonization Research Association in the field of coal chemistry are reported. Coal gasification and liquefaction processes by the Coal Research Establishment are described, and energy conservation measures are analyzed. 1 ref.

53640 Theoretical work on reaction sequences in the gasification of coke by carbon dioxide and by steam in conditions remote from equilibrium. Shaw, J.T. (Natl Coal Board, Gloucestershire, Engl). *Fuel;* **56**: No. 2, 134-136(Apr 1977).

The theory of the kinetics of gasification at atmospheric pressure expounded principally by Ergun is extended to reinterpret the experimental results obtained at pressures up to 5 MPa and temperatures up to 870°C by Blackwood and his co-workers. The reaction sequences that are proposed enable a rate equation to be put forward for the general case of gasification in any mixture of carbon dioxide, carbon monoxide, steam and hydrogen at any pressure and temperature within the range of the original data. An equation for the rate of formation of methane during gasification in mixtures of steam and hydrogen is derived. 7 refs.

53641 Gasification of coals treated with non-aqueous solvents--1. liquid ammonia treatment of a bituminous coal. Matida, M.; Nishiyama, Y.; Tamai, Y. (Tohoku Univ, Sendai, Jpn). *Fuel;* **56**: No. 2, 177-180(Apr 1977).

A Japanese bituminous coal was treated with liquid ammonia at temperatures up to 120°C. Extract was separated from the treated coal by washing with benzene-ethanol mixture. The amount of extract was about 2% in a single treatment at 120°C and some additional extract was obtained by successive treatments. Particles of the residue had cracks and showed an increase in surface area. The ammonia-treated coal was found highly reactive toward gasification with hydrogen at high temperature when catalysed by nickel. 6 refs.

LIQUEFACTION

REFER ALSO TO CITATION(S) 53616, 53619, 53620, 53639, 53663, 53665, 53677

53642 (CONF-770415—1) **Organics in aqueous process streams of a coal conversion bench-scale unit using the hydrocarbonization process: HPLC and GC/MS analysis.** Jolley, R.L.; Pitt, W.W. Jr.; Thompson, J.E. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A02/MF A01.

From 23. IES annual technical meeting and exposition; Los Angeles, California, United States of America (USA) (24 Apr 1977).

A bench-scale study of the coal hydrocarbonization process is being conducted at Oak Ridge National Laboratory. As part of this study, the organic constituents in the aqueous stream from the product scrubber are being characterized using high-pressure liquid chromatography (HPLC) for separation of the water-soluble organics and gas chromatography—mass spectrometry (GC/MS) for identification of the organics. For example, in one preparative-scale HPLC separation, more than 100 uv-absorbing constituents were detected and separated. Using GC/MS techniques, many of these chromatographic peaks were identified as phenolic compounds such as catechol, methylcatechols, orcinol, and resorcinol. These compounds were quantified at concentrations of 10 to 1000 milligrams/liter. Experimental methodology for HPLC and GC/MS techniques is discussed, and analytical results and possible environmental implications are presented.

53643 (CONF-7505139—, pp 147-161) **Conversion of caking coals to low-sulfur fuel oil in the SYNTHOIL process.** Friedman, S.;

Yavorsky, P.M.; Akhtar, S. (Energy Research and Development Administration, Pittsburgh). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

Caking coals are converted in the SYNTHOIL process to low-sulfur low-ash fuel oil environmentally acceptable for power plant use. Data obtained in the current ½-ton per day experimental unit processing several of these coals are discussed. There is no evidence that caking properties of the coals are a significant factor in operations. Process development plans and scale-up time table are presented.

53644 (CONF-7505139—, pp 135-145) **Agglomeration as a factor in the non-catalytic liquefaction of coal.** Skidmore, D. (Coll. of Mineral and Energy Resources, Morgantown, WV). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

Agglomeration does not appear to be a serious factor in the uncatalyzed processing of coal to form liquids for fuel or feedstocks by solvent extraction or dissolution. However, as others have observed, the coals of (ASTM) rank lower than semi-anthracite and higher than lignite tend to form a broad maximum on the percentage solubilization against rank curve. The strong agglomeration tendency range is approximately the same. Reasons for this correlation are discussed in light of (1) accessibility of internal coal structure through pores or crevices both to heat and to solvent action, (2) platelet and lamellar size, shape, fluidity, and chemical reactivity, and (3) release of volatile components to gaseous environment or to liquid solvent by thermal energy. The liquefaction reaction is presumed to begin with imbibition of solvent. Then combined thermal softening and a chemical reaction occur which weaken hydrogen bonding between lamellar layers. Next is a separation of the layers and dispersion into the slurry medium. Finally, the nuclei within lamellae are fragmented by combined thermal and chemical reaction and hydrogen capping of polymer chains. Intermediate processes which promote heat transfer and hydrogen reactivity also promote overall liquefaction reaction. These observations coupled with results from anomalous reactions suggest that the rate determining step in coal liquefaction involves the breaking of hydrogen bonds between lamellae.

53645 (FE—1752-17) **Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-2. Analysis of localized social impacts of coal liquefaction plants. Final report, January 1975—December 1976.** Newitt, J. (Hudson Inst., Inc., Croton-on-Hudson, N.Y. (USA)). May 1977. Contract EX-76-C-01-1752. 46p. Dep. NTIS, PC A03/MF A01.

The development of large-scale coal complexes in sparsely settled areas entails risks of deleterious social impact. If the Federal government is closely associated with the project, obligations and pressures to prevent or mitigate these impacts are especially great. For this report, relevant literature on boom-town dynamics and on the country's major coal-bearing regions has been reviewed to identify types of deleterious impact, and to evaluate and supplement the remedies proposed. The best preventive medicine is seen as incorporating social-impact variables, local attitudes, manpower availability, existing community infrastructure, into the site-selection process. Subsequent planning should generally stress stop-gap measures, at the extreme, temporary new towns, to avoid the risk of saddling communities with a heavy debt burden if the project is abandoned, delayed, or reduced or if costs prove excessive. Risk-sharing possibilities should be studied. Advance definition of social-impact responsibilities for construction, operation and termination phases is desirable. On-site corporate growth managers should have access to expert advice on crisis- and conflict-management. 33 references.

53646 (FE—1752-19) **Issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Management issues. Volume III-4. Steel requiremnts. Final report, January 1975—December 1976.** Thomas, J. (Hudson Inst., Inc., Croton-on-Hudson, N.Y. (USA)). May 1977. Contract EX-76-C-01-1752. 57p. Dep. NTIS, PC A04/MF A01.

The effect of a hypothetical large-scale coal liquefaction industry on the industrial infrastructure of the nation is examined in terms of the ability of the U.S. steel industry and related fabricators to provide the requisite types of steel and steel products in the needed quantities. Two possibly critical areas identified in the Federal Energy Administration's Project Independence Blueprint, Final Task Force Report, are examined in particular: production of heavy steel plate and large pressure vessel fabrication. In order to meet the requirements of a large program the normal lead time to increase steel production capacity is about 5 years. It is concluded that both the steel industry and the fabricators of large pressure vessels appear capable of fulfilling their roles in such a development provided that adequate advance planning occurs and that the required fuel and raw materials inputs are available in the quantities needed.

53647 (FE—2010-7) **Characterization of coal liquids. Intermediate report. Upgrading H-coal hydroclone underflow.** deRosset, A.J.; Gatsis, J.G. (UOP, Inc., Des Plaines, Ill. (USA)). Nov 1976. Contract EX-76-C-01-2010. 12p. Dep. NTIS, PC A02/MF A01.

A 113-kg sample of H-Coal process hydroclone underflow was furnished to UOP Inc. by Hydrocarbon Research, Inc., Trenton, N.J. This is the seventh of eight coal liquids to be characterized as to processability by conventional petroleum refining technology. Laboratory batch filtration of a portion of the sample at 200°C, 500 psig, yielded 24 kg (73 percent) of hydrotreater feedstock, containing 0.12 percent ash, 49 percent C_7-insolubles, and 29 percent benzene insolubles. Bench scale, continues hydrotreatment of the filtrate was carried out at four process conditions, followed by a catalyst activity check at initial (base) condition. The run was terminated voluntarily at 185 hours. However, pressure surges indicated incipient bed plugging, probably due to residual ash. At base conditions the C_7-insoluble conversion was initially 84.8 percent. Decreasing space velocity to one-half base increased conversion to 93.0 percent. Response to a 10°C temperature increase was minor. The final return to base conditions gave only 76.7 percent C_7-insoluble conversion, indicating appreciable catalyst deactivation.

53648 (FE—2010-03) **Characterization of coal liquids. Intermediate report. Upgrading SYNTHOIL.** deRosset, A.J. (UOP, Inc., Des Plaines, Ill. (USA)). Aug 1976. Contract EX-76-C-01-2010. 26p. Dep. NTIS, PC A03/MF A01.

A two drum sample of Synthoil was furnished to UOP Inc. by the Pittsburgh Energy Research Center. This is the third of eight coal liquids to be characterized as to processability by conventional petroleum refining technology. Presence of ash and ammonium chloride necessitated pretreatment by filtration and water washing. Hydrotreating was carried out over a range of process conditions. At base conditions C_7-insoluble conversion was 77 percent. Decreasing pressure to about 0.7 times base doubled the residual C_7-insolubles. In addition to the process variable study, a preparative run was made to produce 15 gallons of hydrotreated Synthoil containing less than 4 percent C_7-insolubles. From 138 hours to termination at 436 hours, the product quality stabilized at 4 percent C_7-insolubles. Compared to UOP filtered SRC filter feed, the Synthoil stock appeared to contain more refractory asphaltenic materials.

53649 (FE—2047-2) **Clean solid and liquid fuels from coal. Quarterly progress report, July—September 1976.** Gary, J.H.; Golden, J.O.; Baldwin, R.M.; Bain, R.L.; Dickerhoof, D.W. (Colorado School of Mines, Golden (USA). Dept. of Chemical and Petroleum Refining Engineering). 15 Oct 1976. Contract EX-76-C-01-2047. 25p. Dep. NTIS, PC A02/MF A01.

This report covers progress during July—September, 1976, on ERDA contract number E(49-18)-2047. During this period experimentation was initiated in the continuous flow processing unit, with three preliminary shakedown runs completed. An initial batch study was also initiated in the catalyst evaluation unit, with a total of 4 runs completed to date. All experimental work on the sulfur forms kinetic study was completed during the past quarter. Preliminary batch autoclave testing of inexpensive catalysts for promotion of the formation of in-situ hydrogen is now being planned. Initial data reduction on the examination of CO-steam residues from lignite liquefaction (cooperative study with Grand Forks Energy Research Center) is underway. The advisory committee was convened on the CSM campus on October 14 for the purpose of reviewing laboratory safety and project progress. Recommendations of the advisory committee are detailed.

53650 (FE—2202-12) **Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Annual report, November 1, 1975—October 31, 1976.** (Stanford Research Inst., Menlo Park, Calif. (USA)). 10 Dec 1976. Contract EX-76-C-01-2202. 98p. Dep. NTIS $5.00.

Initial experiments showed that HCl, H_2, and $AlCl_3$ are important in the hydrocracking of beneficiated coal. A standard set of relatively mild reaction conditions was established for homogeneous acid catalyst screening for conversion of coal to pyridine-soluble materials. Most of the catalysts were tested at two concentration levels and the relative activity differed for the two cases. Catalyst concentration levels and residence times were studied in more detail with the $AlCl_3$/HCl catalyst system. Most of the catalysts investigated lack the ability to upgrade Synthoil appreciably to distillate fuel. Experiments with a filter basket in our autoclave show that supercritical solvents extract no more material than is soluble in the medium at room temperature and pressure after reaction. Thus, filtering under supercritical conditions is unnecessary. In one experiment at 335°C with isopropanol and potassium isopropoxide, a product with 97 percent pyridine solubility was recovered. The

thermochemical properties of polycyclic benzyl radicals and of polycyclic aromatic compounds of other six-membered cyclic and polycyclic compounds related to coal have been calculated. The thermochemistry of the competition between hydrocracking and hydrogenation of hydroaromatic structures was examined and the mechanisms for these competitive pathways to some quantitative scrutinized. An Illinois No. 6 coal sample that has been extracted with pyridine is so reactive that it can be almost completely converted to water-soluble acids at 30°C.

53651 (FE—2211-5) Chemistry of lignite liquefaction. Quarterly report, January—March 1977. Stenberg, V.I. (North Dakota Univ., Grand Forks (USA)). Apr 1977. Contract EX-76-C-01-2211. 49p. Dep. NTIS, PC A03/MF A01.

Nine samples of solvent-refined coals and solvent-refined lignites, both with and without ash, have been analyzed for oxygen by difference (elemental analyses) and neutron activation. The two methods agree reasonably well for seven of the samples but are significantly different for the other two. Because SRL, SRC and heavy liquids were giving unreliable analytical data (nmr, uv and molecular weights) and samples which were supplied as "deashed" were not deashed in a uniform way, a standard deashing procedure was developed for all samples prior to obtaining analytical data for SRL and SRC comparison. The procedure is outlined. Ultraviolet spectra of deashed SRLs and SRCs are unable to demonstrate significant differences between the two. Analysis of nuclear magnetic resonance spectra of carbon 13 compounds by pulsed Fourier transform techniques has been adopted to SRL and SRC samples. Successful completion of this project will give an aromatic to aliphatic carbon ratio directly and more accurately than proton magnetic resonance spectroscopy. Vapor phase osmometry is being used for determining molecular weights of SRL and SRC samples. 21 batch autoclave experiments have been carried out with five different catalysts to determine optimum liquefaction conditions. The reduction of the model compounds anthracene and quinoline using CO-H_2O, H^2 and CO-H_2O-H_2 gases and with and without solid catalysts has been done.

53652 (FE—2328-4) Deuterium tracer method for investigating the chemistry of coal liquefaction. Quarterly technical progress report, June—September 1976. Skowronski, R.P.; Ratto, J.J.; Heredy, L.A. (Atomics International Div., Canoga Park, Calif. (USA)). Oct 1976. Contract EX-76-C-01-2328. 25p. Dep. NTIS, PC A02/MF A01.

The objective of this research is to achieve a better understanding of the mechanism of coal hydrogenation. A deuterium tracer method is being developed to achieve that objective. Three exploratory hydrogenation tests have been completed and the products solvent-fractionated. The solubility data appear to be consistent with a simplified sequential reaction mechanism. Also, the first test in the planned series of protium/deuterium test pairs has been completed. Solvent-fractionation of the products is in progress. The soluble products from all three exploratory hydrogenation experiments have been analyzed by proton nuclear magnetic resonance spectroscopy. Evaluation of the products from the first two tests is complete; evaluation of the products from the third is in progress. The data give the relative number of protons in different structural positions. Soluble products from the deuteration experiment are being analyzed by proton-NMR and will also be analyzed directly with a deuterium probe. This will give a direct check of the data obtained by difference from the proton-NMR spectra. Also, the absolute weight fraction of the deuterium in these products will be determined by combustion analysis. The water formed in these analyses will be trapped out and analyzed by mass spectrometry for ^1H_2O and ^2H_2O content. The preliminary selection of model compounds for future hydrogenation/deuteration tests has been completed. These model compounds will be used to calibrate the NMR spectrometric method for analysis of Phase I data. This work will also establish a firm foundation for and facilitate transition to Phase II of the research.

53653 (GFERC/QTR—77/2) Quarterly technical progress report, January—March 1977. Gronhovd, G.H. (Energy Research and Development Administration, Grand Forks, N.Dak. (USA). Grand Forks Energy Research Center). Jun 1977. 58p. Dep. NTIS, PC A04/MF A01.

Six papers representing the Grand Forks Energy Research Center Quarterly Report have been entered individually into EDB and ERA. The work covers coal liquefaction (COSTEAM process), coal gasification (slagging, fixed bed pilot plant), fluidized-bed combustion of lignite and subbituminous coals, sulfur dioxide removal from flue gas using ash-alkali wet scrubbers, fly ash removal by electrostatic precipitators and experimental tests aimed at controlling ash fouling in boilers using western coal with a high sodium content. (LTN)

53654 (GFERC/QTR—77/2, pp 1-13) CO-Steam process. Sondreal, E.A. Jun 1977.

In Quarterly technical progress report, January—March 1977.

The temperature-dependent depolymerization that occurs during coal liquefaction was observed at 440, 450, 460, and 470°C; the greatest change was observed upon reaching 460°C. A dramatic drop was seen in the concentration of high molecular weight material when a slurry was heated between 450 and 460°C; temperatures in this range appear to be a minimum for the rapid production of oil by the CO-Steam process. Additional non-aqueous titration data have indicated that oil, asphaltene, preasphaltene, and THF insoluble residue of a 470°C product made at GFERC contains only half the weak acid groups of a comparable product made at lower temperatures. Four autoclave runs were performed in order to obtain accurate material balance and yield data. Work on the continuous process unit has been slowed by problems in the interlock system, but some pressure testing has been done. Methods have been investigated for the rapid evaluation of CO-Steam product quality. A column chromatographic method for determination of hydrocarbons plus ethers and polar/polymeric materials is under development. The HPLC procedure for molecular weight distribution will also yield data on the extent of coal depolymerization by taking a ratio of absorbances for 950 MW and 250 MW in the chromatograms. The unexpected appearance of dimers and methylated homologs has been observed in several reaction mixtures where pure compounds were reacted under CO-steam conditions. Cracking of naphthenic rings appears to give rise to the radicals needed to promote these reactions. Nitrogen compounds in the CO-Steam product and other coal liquids have been identified and measured. A number of acidic nitrogen species (carbazole and benzocarbazoles) were found in significant concentrations.

53655 Production of low-sulfur fuel oils from Utah coals. Qader, S.A.; Hill, G.R. (Univ. of Utah, Salt Lake City). *Adv. Chem. Ser.;* **127**: 91-97(1973).

Hydrogenation of high-volatile bituminous coal under high temperatures and pressures produced low-sulfur fuel oils. At a coal conversion of 80 percent, the ratio of oil to gas yields was approximately 3 : 1 and 23 percent of the coal sulfur was contained in the oil. Sulfur content of the oil, however, remained the same at different coal-conversion levels. The data obtained in the semicontinuous dilute-phase hydrogenation system showed that the whole oil can be directly used as a fuel oil where 1 percent sulfur is tolerated. Fuel oils containing 0.5 percent and 0.25 percent sulfur were produced by desulfurization of the whole oil.

53656 Coal utilization in the South. Harrison, W.B. pp 232-247 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

Unless breeder reactor technology is developed our major future energy source is coal, with presently proven reserves of natural gas and oil being quite limited and oil from shale not yet commercial. Since oil and natural gas supply about 80 percent of our present energy consumption but represent less than 10 percent of our total domestic energy reserves (even excluding breeder reactors), it is imperative that a major change in our energy policy and future energy alternatives is recognized. Probable future changes in energy for electric power generation are sketched to 2000, with the major dependence being on coal. But some method of using high sulfur coal is necessary: Fuel processing (removal of sulfur and mineral matter before burning, flue gas scrubbing or fluidized-bed combustion (in the Southern USA there is little low sulfur coal available locally)). Flue gas scrubbing is regarded as nearer commercialization and improving; fluidized-bed combustion looks promising but major changes in design and operation are required; so the author prefers coal processing and by the solvent-refined coal process. This process produces a high calorific value, solid fuel like coal, which is very low in ash (0.11 percent) and in sulfur (0.8 percent). Savings include lower transport cost, conventional, and standard, plant design, higher plant availability, reduced maintenance, etc. (LTN)

53657 Coal liquefaction economics. Wellman, P. pp 260-279 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

The status of several coal liquefaction projects is described briefly and of the H-COAL process in more detail and with projected economics. The H-COAL process is a high pressure catalytic hydrogenation of coal in an ebullating bed. The reactor operates at 3200 psig and at about 840°F. The projected cost of the synthetic petroleum varies with the assumed cost of coal ($15 to $25/per ton) and with the DCF rate of return (12 to 20 percent), but is of the order of twice the present price of imported petroleum. (LTN)

53658 Wednesday afternoon roundtable discussion, February 2, 1977. pp 304-318 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

There is a minor dust problem with solvent-refined coal but it is not serious and additional efforts are being made to reduce it. Lignite can be solvent-refined, but the efficiency of lignite conversion may be less and the cost greater than for coal. The cost of a solvent-refined coal plant and an associated power plant has been compared with that of a similar power plant using raw coal and scrubbing the flue gas; it was concluded that solvent-refined coal is a viable alternative. Further questions involved the comparison of unit trains and slurry pipelines. The Black Mesa 275 mile slurry pipeline is regarded as a success (two blockages were easily taken care of). Automobile traffic delays caused by unit trains are considered. Sulfuric acid is not regarded as a good product of scrubbers (you can't throw it away and you can't store it); sulfur or gypsum may be better. Fertilizers are mentioned as a possible market. Magnetohydrodynamic power plants are considered a long shot by most, but not all, of the utility people. There should be a better way of resolving the problems involved with power plant authorization, construction and operation with respect to environmental problems, environmental groups, conflicting and changing rules by various state and federal agencies, etc. Some suggestions are made. (LTN)

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 53611

53659 Effect of argon and nitrogen atmospheres and cracking catalyst on flash pyrolysis of makum coal. Banerjee, N.N.; Ghosh, B.; Nair, C.S.B. (Cent Fuel Res Inst, Dhanbad, India). *Fuel;* **56**: No. 2, 192-194(Apr 1977).

Makum coal (Assam) was subjected to flash pyrolysis at a temperature of about 1150°C for 30 s in vacuo and under various pressures of nitrogen and argon. In a few cases pyrolysis was carried out in the presence of some cracking catalysts. Both the pyrolytic atmosphere and the quenching temperature play a significant role in favoring higher yields of olefins. 4 refs.

SOLVENT EXTRACTION

REFER ALSO TO CITATION(S) 53807

53660 (FE—2010-02) **Characterization of coal liquids. Intermediate report for the period January—March 1976. Upgrading cut back solvent refined coal.** deRosset, A.J. (UOP, Inc., Des Plaines, Ill. (USA)). May 1976. Contract EX-76-C-01-2010. 11p. Dep. NTIS, PC A02/MF A01.

Solvent Refined Coal (SRC) furnished to UOP Inc. by Pittsburg and Midway Coal Co., Ft. Lewis Washington was cut back with SRC process solvent distilled from SRC filter feed received in a previous shipment. The blend was catalytically hydrotreated under severe conditions, including two space velocities and two temperatures. Initial conversions of nitrogen and heptane insolubles were similar to previously reported conversions obtained processing the filtered and vacuum stripped SRC filter feed. Severe catalyst deactivation occurred, attributed to residual ash or high molecular weight asphaltenic materials.

53661 (FE—2010-04) **Characterization of coal liquids. Intermediate report. Upgrading SRC filtrate.** deRosset, A.J. (UOP, Inc., Des Plaines, Ill. (USA)). Sep 1976. Contract EX-76-C-01-2010. 13p. Dep. NTIS, PC A02/MF A01.

A four drum sample of Solvent Refined Coal (SRC) filtrate was furnished to UOP Inc., by Pittsburg and Midway Coal Company, Ft. Lewis, Washington. This is the fourth of eight coal liquids to be characterized as to processability by conventional petroleum refining technology. One drum of the sample was topped in laboratory vacuum flash equipment to yield a 30 wt. percent bottoms containing 0.04 percent ash, and 38.4 percent C_7-insolubles. The bottoms product was catalytically hydrotreated over a range of process conditions. At base conditions, initial C_7-insoluble conversion was 83.9 percent. Raising the temperature 10°C, and decreasing space velocity to one-half base increased this conversion to 93.1 percent. A return to base conditions at 184 hours of catalyst service showed only 74.5 percent conversion. Change in catalyst activity was comparable to that obtained with Synthoil containing the same amount of ash, and to that obtained with 20 percent cutback SRC containing 0.17 percent ash. However, tests of longer duration are preferred for proper assessment of catalyst stability.

53662 (FE—2010-06) **Characterization of coal liquids. Intermediate report. Upgrading solvent refined coal.** deRosset, A.J. (UOP, Inc., Des Plaines, Ill. (USA)). Nov 1976. Contract EX-76-C-01-2010. 16p. Dep. NTIS, PC A02/MF A01.

Solvent Refined Coal (SRC) furnished to UOP Inc. by the Pittsburg and Midway Coal Co., Ft. Lewis, Washington, was catalytically hydrotreated without addition of extraneous solvent. This was accomplished by recycling hydrotreated product as solvent at a combined feed ratio of 2.0 to 2.5. Yield of fuel product from SRC was 98+ wt. percent at 3800 SCF/B hydrogen consumption. Addition of hydrogen compensated for yield loss to water, ammonia, and hydrogen sulfide. Product slate (weight percent) comprised 1.5 percent gas, 5.2 percent gasoline, 5.6 percent kerosine, 32.7 percent light gas oil, 14.2 percent heavy gas oil, and 40.8 percent 850°F+ bottoms.

53663 Composition of coal liquefaction products. Schiller, J.E. (Grand Forks Energy Res Cent, ND). *Hydrocarbon Process.;* **56**: No. 1, 147-152(Jan 1977).

Results are presented of an experimental program in which effect of process variables during coal liquefaction on the composition of the solvent refined coal (SRC) and similar synthetic fuels was studied. It is shown that vigorous hydrogenation of coal increases the amount of oxygen compounds and decreases the amount of nitrogen compounds in distillable products. Naphthalenes and phenanthrenes are the major aromatics from mild hydrogenation, but acenaphthene/biphenyl are more abundant in vigorous hydrogenation distillates. Unremoved solvent or 3 and 4 condensed ring aromatics account for the major amount of distillable material in SRC. The average molecular weight of SRC is reduced by vigorous reaction conditions. Aromatics in coal conversion distillates exhibit a low degree of alkylation. 12 refs.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 53663, 53693

53664 World coking coal market until 1985. Rumberger, M.; Wettig, E. *Glueckauf;* **113**: No. 2, 86-91(20 Jan 1977). (In German with English abstract).

Definition of coking quality and supply conditions for the steel industry are followed by review of production figures from main producing countries. Geographical distribution of consumption is analyzed, and expected changes in marketing trends are forecast.

53665 Formation of benzene polycarboxylic acids in the oxygen oxidation of solid by-products from coal-conversion processes (ccp) in an alkaline medium. Eisenberg, W.C.; Solomon, I.J. (IIT Res Inst, Chicago, Ill). *Fuel;* **56**: No. 2, 181-184(Apr 1977).

Solid and liquid carbonaceous by-products have been obtained in both coal gasification and liquefaction processes. A study of the oxidation of the solid by-products was undertaken to determine what commercial chemicals could be derived from these materials. The oxygen oxidation of various coal-conversion-process by-products in 10% aqueous sodium hydroxide was investigated at 250$degree$C and a total pressure of 8.27 MPa. The products isolated were carbon dioxide and the organic extract, a complex mixture of aliphatic and aromatic acids. The benzene polycarboxylic acids were the major component of the organic extract. 6 refs.

PROPERTIES

REFER ALSO TO CITATION(S) 53607, 53608, 53612, 53614, 53643, 53644, 53723, 53809, 53810, 53817, 54891

53666 (CONF-7505139—) **Proceedings of the coal agglomeration and conversion symposium.** Smith, C.J. (comp.). (West Virginia Geological and Economic Survey, Morgantown (USA)). Apr 1976. 241p. Virginia Geological and Economic Survey, Morgantown, WV.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

The 20 papers presented at the conference were abstracted and indexed separately. (EJH)

53667 (CONF-7505139—, pp 1) **Effects of oxidation on the chemical structure and properties of coals.** Breger, I.A.; Zubovic, P.; Chandler, J.C.; Ligon, D.T. Jr. (Geological Survey, Reston, VA). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

Samples of three high-volatile bituminous coals from Illinois, a subbituminous C coal from Montana, and a lignite from South

Dakota were oxidized at 100°C under forced air draft in a specially designed rotating oven. Parts of each sample were removed from the oven for analysis after intervals ranging from 48 to about 1000 hr. Similar oxidations of samples from the same coals were also carried out at 120, 140, and 160°C. The prime objectives were: (1) to study the kinetics of oxidation at various temperatures; (2) to obtain information on the mechanism of oxidation; (3) to study the relationship between the degree of oxidation and the agglomerating character of the bituminous coals; (4) to obtain information on the relationship of sulfur content to oxidation characteristics of the bituminous coals; (5) to detect, if possible, factors that might influence spontaneous combustion of coal; and (6) to evaluate the effects of oxidation; under controlled conditions, on the reflecting properties of the coal macerals.

53668 (CONF-7505139—, pp 9-20) **Inorganic geochemistry of Illinois agglomerating coals.** Gluskoter, H.J. (Illinois State Geological Survey, Urbana). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

Coals in the Illinois Basin range in rank from high-volatile C bituminous to high-volatile A bituminous and increase in rank rather uniformly from the northwest to the southeast. The minerals commonly occurring in Illinois coals are illite, kaolinite, mixed-layer clays, quartz, calcite, and pyrite. Siderite, feldspar, marcasite, sphalerite, apatite, barite, and galena also have been identified but generally not in significant amounts. Mean values of the mineral content of 65 coal samples are: total clays, 52%; pyrite, 23%; quartz, 15%; and carbonates, 9%. A recent study of 82 coals from the Illinois Basin characterized the coals according to major, minor, and trace elements and the normal coal parameters. The mean ash (high-temperature ash) values for the 82 samples is 11.18%, and the mean mineral-matter content is 15.22%. Data from chemical analyses of coals that were washed (separated into different specific gravity fractions) allow the trace elements to be separated into groups of various organic and inorganic affinities. Gieseler plasticity and free-swelling index (FSI), both of which relate to agglomerating characteristics of coals, were determined on the coals that were also chemically analyzed. Except for parameters obviously related to rank, only a very few statistically significant relations were observed. The values (temperatures) from the Gieseler plasticity determinations correlated negatively with sulfur content of the coals, and both the Gieseler values and the FSI correlated negatively with boron in the coal. Neither of these relations is due to the effect of sulfur or of boron on the agglomerating characteristics of the coals.

53669 (CONF-7505139—, pp 21-24) **Inorganic geochemistry/mineralogy of West Virginia agglomerating coals.** Renton, J.J. Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

When introduced into a coal conversion process, the inorganic portion of coal is an impurity with the potential to detrimentally affect both the process and the products of the coal conversion technique. As a result, the evaluation of a coal for a particular process must include a detailed determination of the inorganic composition of the coal. High-temperature ashing will not provide the necessary data because of the modification and alteration that the inorganic portion undergoes during the ashing process. Low-temperature ashing on the other hand provides an essentially inaltered sample of the inorganic portion of coal. The major mineral components in West Virginia coal are quartz, kaolinite, illite, and pyrite with calcite occurring as a minor impurity. Regional and local studies have indicated that these components are distributed through the coal in a systematic, and therefore predictable, way. The establishment of the three dimensional distribution of the inorganics will permit a more detailed evaluation of coal for coal conversion processes and may well be a major consideration in the procedure by which the coal is mined.

53670 (CONF-7505139—, pp 25-36) **Porosity and internal surface area of Illinois agglomerating coals.** Thomas, J. Jr.; Damberger, H.H. (Illinois State Geological Survey, Urbana). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

The efficiency of coal gasification, liquefaction, and solubilization processes probably depends upon, among other factors, the internal surface area (ISA) of the coal used and its accessibility. The ISA of Illinois coals, determined from carbon dioxide absorption, ranges from 46 m^2/g for high-volatile A bituminous (hvAb) coal to 292 m^2/g for high-volatile C bituminous (hvCb) coal. The ISA correlates well with moisture content, which is a recognized parameter for rank of Illinois coals. Illinois hvCb coals have much greater porosity than hvAb coals. Mercury intrusion data show that Illinois hvCb coals contain many pores with diameters from 90 to 220 A, whereas pores this large are virtually nonexistent in hvAb coals, in which most pores appear to be smaller than 35 A. These pore-size variations probably are indicative of different former depths of burial. The hvAb coals are actually more porous than ISA measurements with carbon dioxide would indicate. This is borne out by the large increase in ISA (from 50 m^2/g to 200 m^2/g) that accompanies the loss of only small quantities (less than 5%) of volatile organic matter under carefully controlled heating conditions. Thus, it appears that the hvAb coals, in addition to having smaller pores than hvCb coals, have much of their internal pore structure plugged by relatively low-boiling organic constituents.

53671 (CONF-7505139—, pp 37-61) **Use of microscopic procedures to determine the extent of destruction of agglomerating properties in coal.** Gray, R.J.; Krupinski, K.C. Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

Most of the commercial coals available in the eastern and midwestern United States soften and agglomerate when heated and thus are difficult to use for some types of gasification or for char production. However, these coals will agglomerate to a lesser degree when treated by thermal oxidation. The changes in the microscopic appearance of coal that accompany treatment in an oxidizing atmosphere are presented in detail. A miniature fluid bed used to prepare samples and also used in a dynamic test of the agglomerating properties of treated coal is described. In general, it is shown that the rank of the vitrinoids (measured by reflectance) determines the plastic properties of coals. Fusinoids, semifusinoids, and micrinoids are virtually infusible. Bituminous coals with lower-rank vitrinoids ($<0.6\%R_o$) and those with higher rank-vitrinoids ($<1.9\%R_o$) decompose before softening and are non-agglomerating. The bituminous coals of intermediate rank pass through a plastic stage during heating. Oxidation of coal decreases its plasticity and agglomerating tendencies. Thermal oxidation of all the bituminous coals examined proceeded topochemically. Discernible rings of higher reflecting material developed around the unoxidized portions of the coal particles. Coals that became highly fluid in the Gieseler plastometer test retained some agglomerating properties when tested in a fluid bed and in the free-swelling-index test even after oxidation at 400°C for 30 minutes.

53672 (CONF-7505139—, pp 85-111) **Agglomerating properties as measured by coal petrography applied through conventional test procedures.** Leonard, J.W.; Donahue, B.A. Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

A coal company that is interested in applying conventional petrography can begin by taking apart a coal seam, band by band, and by subjecting each band to a wide variety of conventional analyses. These analyses may include, but not necessarily be limited to, such determinations as ash, sulfur, volatile matter, calorific value, free swelling index, Hardgrove Grindability Index, and bulk specific gravity. Petrographic standardization graphs can be developd to relate each individual analysis to the other analyses in coal increments. Thus, by collecting petrographic increments across the stream of classifying, concentrating or flotation units in a preparation plant and by running a single analysis on each increment, the relative distribution of many coal characteristics within each increment of the product can be determined. More important, the final plant product can be similarly analyzed by rapid laboratory separation into petrographic fractions. Supplemental findings indicate that hard increments in coal tend to be less extensively coking than the softer increments. These observations can be useful for designing a coal product. By applying a small number of rapidly determined tests (MM, VM, and FSI) to fractions of coal which are separated from a single sample, it is possible to estimate the magnitude of a number of additional and less simply determined coal properties (Btu, HGI, Δtau, and BSG) for numerous coal seams. By closely qualifying such known relationships as Btu vs. MM and MM vs. BSG, developed for distinct petrographic bands, it is possible to develop an unexpectedly close correlation of coal properties.

53673 (CONF-7505139—, pp 113-118) **Experimental enhancement of agglomerating properties in lignite.** Ting, F.T.C. (West Virginia Univ., Morgantown). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

Fresh woody lignite (xylain) containing low concentration of cations are found to exhibit agglomeration phenomena upon heating in a volatile-matter crucible. Increasing concentration of cations tends to destroy the agglomerating properties of woody lignite. Non-agglomerating woody lignite can be rendered to agglomerate by washing the samples with dilute acid solutions (5% HCl). Untreated samples may exhibit free-swelling index of 1 to 1⅓ whereas acid-treated samples may show a free-swelling index of 3⅓ to 4. Gieseler plasticity test indicates initial softening temperature at 300°C, maximum fluidity at 345°C, and resolidification at 400°C. The maximum fluidity is 2.5 dial divisions per minute. The agglomerating properties of acid-treated woody lignite is destroyed if the sample is washed with solutions containing sodium, calcium, or other alkali cations.

53674 (CONF-7505139—, pp 175-185) **Deagglomeration of coals.** Gasior, S.J.; Forney, A.J.; Haynes, W.P.; Kenny, R.J. Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

Many of the U.S. coals are caking coals. They require that their caking properties be destroyed before being fed to many of the coal gasifiers under development. Conditions are described for destroying the agglomerating or caking quality of mildly caking Illinois No. 6 and of strongly caking Pittsburgh seam coals by entrained free-fall, and fluidized-bed methods at 40 and 70 atmospheres pressure. Destruction of the caking property was accomplished by exposing coal particles ranging in size from a nominal 30 to 570 microns to an inert gas containing 7-12 vol.% oxygen at 415-470°C.

53675 (CONF-7505139—, pp 205-214) **Destruction of agglomeration properties of coal.** Wesley, D.; Hahn, O.J. Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

The pretreatment of Kentucky No. 9 Coal to eliminate agglomerating properties has been investigated. Sized coal was soaked in aqueous sodium hydroxide solutions of various concentrations, filtered, and dried in a vacuum oven at -28 inches Hg and 100°C. The agglomerating properties were considered to be destroyed when the char produced from carbonization of the pretreated coal in a fluid-bed reactor at 700-800°C flowed relatively freely from the reactor vessel. Other test methods to evaluate the agglomerating properties of coal before and after the sodium hydroxide were tried. Decreasing coal size and increasing sodium hydroxide concentration were found to decrease the caking propensity of the treated coal.

53676 (CONF-7505139—, pp 3-8) **Some comments on the chemistry of the agglomerating tendency of coals.** Given, P.H. Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

A simple physical picture of the coking process is presented, in which the production and time of retention of tarry substances inside the pores of coal particles are held to be crucial. The reactions producing these substances include loss of phenolic OH and hydroaromatic hydrogen. The dependence of the Free Swelling Index on rank and other parameters is discussed, and its value for predicting the extent of agglomeration in gasification processes is shown to be questionable. It is shown that the agglomerating behavior of coals depends strongly on their petrographic composition as well as rank and rate of heating.

53677 (FE—2035-7) **Enthalpy measurement of coal-derived liquids. Quarterly technical progress report, January—March 1977.** Kidnay, A.J.; Yesavage, V.F. (Colorado School of Mines, Golden (USA). Dept. of Chemical and Petroleum Refining Engineering). 29 Apr 1977. Contract EX-76-C-01-2035. 19p. Dep. NTIS, PC A02/MF A01.

Evaluation and testing of the calorimetric facility was completed. Data were obtained for n-heptane at 154 psia over the liquid, two phase and vapor region. The results are in essential agreement with data from previous workers. Experimental measurements were complete for a liquid derived from a Western Kentucky coal by the COED process over the range of 100 to 1500 psia and temperatures from 65°F to 700°F.

53678 (FE—2316-1) **Study of the mineral matter distribution in pulverized fuel coals with respect to slag deposit formation in boiler furnaces: phase I. Interim report, April—June 1976.** Austin, L.G.; Essenhigh, R.H.; Ohmine, S.; Morris, B. (Pennsylvania State Univ., University Park (USA). Dept. of Material Sciences). Oct 1976. Contract EX-76-S-01-2316. 20p. Dep. NTIS, PC A02/MF A01.

A sample of pulverized coal from the Keystone Power Station has been used to test the operation of the plane flame (non back-mixed) slagging furnace. Ashes from this coal have been melted in an arc-image furnace, and measurements of contact angle of the slag drop on graphite have been made. It has been concluded that results from the arc-image furnace are not sufficiently reproducible, and design and construction of a new furnace is progressing. A meeting has been held to discuss collection of coal samples from operating power plants.

53679 (IS-ICP—39) **Significance of colloidal pyrite distribution for improving sulfur determinations in coal.** Greer, R.T. (Iowa State Univ. of Science and Technology, Ames (USA)). 1976. 5p. (CONF-7608100—1). Dep. NTIS, PC A02/MF A01.

From International symposium of analytical chemistry in the exploration, mining and processing of materials; Johannesburg, South Africa (23 Aug 1976).

Organic sulfur in coal is usually determined simply as the difference between total sulfur and the sum of pyritic and sulfate sulfur. Much of the organic sulfur may actually be undissolved pyritic sulfur which does not appear in the pyritic sulfur determinations. Standard procedures stipulate that 60 mesh coal (250 μm diameter) be used in the tests. However, much of the sulfur can be distributed in colloidal crystallites and in framboid clusters commonly as frequent as every 10 micrometers. Thus, since the organic components of coal are less soluble in acids such as the HCl or HNO_3 used in these tests, much of the pyrite remains undissolved. The uncertainty in chemical determinations is therefore expected to be great, and this has an important bearing on not only the choice of sulfur removal technique, but also basic information as to just how much sulfur really has to be incorporated in the structure of coal.

53680 (LA—6822-PR) **Trace element characterization and removal/recovery from coal and coal wastes. Work plan, October 1, 1976—September 30, 1977.** Wewerka, E.M.; Williams, J.M.; Vanderborgh, N.E. (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1977. Contract W-7405-ENG-36. 14p. Dep. NTIS, PC A02/MF A01.

This document is a statement of planned tasks and technical activities for the EPA-ERDA program on trace element contamination from coal and coal preparation wastes for FY 77. The major emphasis of the investigation is on laboratory studies of the structure, chemistry and environmental behavior of coal and coal refuse from the Illinois Basin. Early in the year, the analyses of the trace elements and major minerals in bulk coal and refuse samples will be completed. This activity will be followed at midyear by studies to elucidate the structural relationships and associations among the trace elements and mineral matrices of these materials. Weathering and leaching studies will be conducted throughout the year to define the chemical behavior of the trace elements in the coal and waste materials under simulated environmental conditions. These research activities are directed at identifying the trace elements of environmental concern in the aqueous drainage from coal waste dumps and storage areas.

53681 **Luminescence spectra of some N,O-diacetyl derivatives of fluoranthene and their pyrolysis products.** Shenbor, M.I.; Tikhonov, V.I.; Kunavin, N.I. *J. Appl. Spectrosc. (USSR) (Engl. Transl.);* **23**: No. 5, 1470-1472(Nov 1975).

The polycyclic nonalternant hydrocarbon fluoroanthene (I) is the third most common constituent of coal tar after naphthalene and phenanthrene. Fluoranthene and its derivatives possess characteristic luminescence properties, such as anomalous stability to fluorescence quenching. The study of the luminescence spectra of this series of compounds is of interest not only for theoretical, but also practical, reasons. In the present work the authors present the luminescence spectra of di- and trisubstituted fluoranthenes: 8-acetamino-9-acetoxyfluoranthene (II), its haloderivatives 8-acetamino-9-acetoxy-10-chlorofluoranthene (III) and 8-acetamino-9-acetoxy-10-bromofluoranthene (IV), and also their cyclized derivatives, prepared by pyrolysis, namely, 9-methylfluorantheno[8,9--d]oxazole (V), 11-chloro-9-methylfluorantheno[8,9--d]oxazole (VI), and 11-bromo-9-methylfluorantheno[8,9--d]oxazole (VII). 9 refs.

53682 **Guidelines for sample collecting and analytical methods used in the U.S. Geological Survey for determining chemical composition of coal.** Swanson, V.E.; Huffman, C. Jr. Washington, DC; Geological Survey (1976). 15p.

In general, the exact type and number of samples of coal and associated rock to be collected are left to the best judgement of the geologist. Samples should be of unweathered coal or rock and representative of the bed or beds sampled; it is recommended that two channel samples, separated by 10 to 100 yards and weighting 4 to 5 pounds each, be collected of each 5 feet of vertical section. Care must be taken to avoid any sample contamination, and to record the exact locality, thickness, and stratigraphic information for each sample. Analytical methods are described for the determination of major, minor, and trace elements in coal. The methods used to

determine these elements include atomic absorption spectroscopy, x-ray fluorescence spectroscopy, optical emission spectroscopy, spectrophotometry, selective-ion electrode, and neutron activation analysis. Refs.

53683 Structure and properties of cokes in the blast furnace. Gol'dshtein, N.L.; Zlatoustovskii, D.M.; Zvereva, N.N.; Zemlyanskov, V.A. (Magnitogorsk Min-Metall Inst, USSR). *Steel USSR;* **6**: No. 4, 177-179(Apr 1976).

The reactivity and structure of the following cokes have been investigated by means of the X-ray diffraction method: skip, taken from the tuyeres and slag-notch region, and potash-impregnated skip. As coke passes through the blast furnace its impregnation with alkali-metal compounds results in a sharp rise in reactivity, and the structure and physicochemical properties become equalized, so that the normally determined reactivity for skip coke does not characterize coke behaviour in the blast furnace. As coke descends the furnace its degree of graphitization increases. 8 refs.

53684 Error in determination of ash content of coal by the method of x-ray transmission and x-ray and beta scattering. Burek, R. *Przegl. Gorn.;* **32**: No. 11, 504-507(Nov 1976). (In Polish with English abstract).

The accuracy of determination of ash content of coal by radiometric method based on absorption and X-ray radiation scattering with 60 kev and on beta radiation is determined. The tests are carried out on coal samples taken from different areas of the Upper Silesian Coalfield. The differences between determination by the orthodox method and the respective radiometric method are taken as a measure of accuracy. It is found that in the case of the method based on beta particle scattering the differences range from 0.3 to 3.3% of ash, while in the case of methods based on the use of X-ray radiation they range from 0.4 to 17% The variable iron content of coal is a factor which reduces the accuracy of methods using X-ray radiation. 6 refs.

53685 Use of microscope-electronic and x-ray methods for tests on coal structure. Lonak, I. *Przegl. Gorn.;* **32**: No. 11, 508-510(Nov 1976). (In Polish with English abstract).

A general description of the apparatus and the capability of electron microscope are given. The procedure of preparing the samples is discussed with a particular reference to coal samples. A method for petrographic tests with the use of X-ray diffraction and microscope-electronic analysis are presented. 8 refs.

53686 Mechanical properties of the Pittsburgh coal at elevated temperatures. Shoemaker, H.D.; Shuck, L.Z.; Haynes, R.R.; Advani, S.H. (Morgantown Energy Res Cent, ERDA, Va). *J. Pressure Vessel Technol.;* **99**: No. 1, 192-198(Feb 1977).

Mechanical properties of coal have been determined in an effort to advance in situ coal gasification technology. Tests and apparatus were developed to evaluate the directional compressive and shear properties of coal at elevated temperatures. Both creep and stress-relaxation properties in compression and shear, at temperatures between 75° and 650°F (24° and 343°C), and normal to coalbead orientation, and four different specimen sizes. Stress-strain relations and ultimate strengths were also determined at three different loading rates for these directions and temperatures. A shift function was used to represent the creep and stress relaxation properties as functions of time and temperature. Four- and six-parameter viscoelastic fluid models were used to represent the data over the time-temperature ranges. Shallow and deep mine coal from the Pittsburgh coalbed was tested. The coal was found to have the greatest ultimate strength and elastic moduli at 200°F (93°C) in all directions in both compression and shear, and to be specimen size dependent. The ultimate strength in the normal to coalbed direction was approximately twice that in the face and butt cleat directions at all temperatures. At 575° to 650°F (302° - 343°C), the coal becomes fluidic and is well represented by a four-parameter fluid model. It also obeys the time-temperature superposition principle.

53687 Interaction between coke and a tar. I. Influence of the surface chemical functions of coke. Lahaye, J.; Aubert, J. (Cent de Rech sur la Phys-Chim de Surf Solides, Mulhouse, Fr). *Fuel;* **56**: No. 2, 185-187(Apr 1977).

Experimental results are given of a study about the relation between oxygen-containing functions of cokes and contact angles of tars on cokes. Using two different cokes, a coal-tar pitch and polymer models, they showed that the coke--tar interactions depend on the hydrogen bonding between the two components and that above a critical value surface-chemical-function content has no influence on coke--tar interactions. 13 refs.

53688 Formation of porous structures in activated brown-coal chars using O_2, CO_2, and H_2O. Tomkow, K.; Siemieniewska, T.; Czechowski, F.; Jankowska, A. (Tech Univ of Wroclaw, Pol). *Fuel;* **56**: No. 2, 121-124(Apr 1977).

Two brown coals, xylitic and earthy, carbonized at 1173 K were activated with water vapor, carbon dioxide and oxygen, each producing a different distribution of porosity. In the xylitic coke, activated in the range of burn-offs from 1 to 70%, the action of water vapor results in the development of pores of all dimensions. Previous results indicate the advantages of using xylitic brown coal carbonized at a temperature close to that at which industrial, high-temperature cokes are prepared. A limited series of experiments, for comparison, was carried out with the earthy brown coal. 6 refs.

53689 Possibility of micropore analysis of coal and coke from the carbon dioxide isotherm. Medek, J. (Min Inst of Czech Acad of Sci, Prague). *Fuel;* **56**: No. 2, 131-133(Apr 1977).

For the study of the microporous structure of coal, semicoke and cokes the carbon dioxide isotherms within the temperature range from 195 to 298 K have been applied. The determination of pore-size distribution and effective surface area of micropores was carried out by means of relations derived from Dubinin's two-parameter equation. 21 refs.

53690 Self-ignition and mechanisms of interaction of coal with oxygen at low temperatures. I. Changes in the composition of coal heated at constant rate to 250°C in air. Marinov, V.N. (Energoproekt, Dep of Sci Res, Sofia, Bulg). *Fuel;* **56**: No. 2, 153-157(Apr 1977).

The changes in weight, in elementary composition, in content of oxygen functional groups and in spin concentration of lignite, brown and black coal samples heated in a stream of humid air at a rate of 1°C/min to various temperatures have been determined. I.r. spectra of oxidized and non-oxidized brown coal are recorded and the yields of CO, CO_2, and H_2O were measured. The results permit coal oxidation to be considered as a redox process. The aromatic part of coal is believed to act as an oxidizing agent in the region where hydrogen is less affected by molecular oxygen. 23 refs.

53691 Self-ignition and mechanisms of interaction of coal with oxygen at low temperatures. II. Changes in weight and thermal effects on gradual heating of coal in air in the range 20-300°C. Marinov, V.N. (Energoproekt, Dep of Sci Res, Sofia, Bulg). *Fuel;* **56**: No. 2, 158-164(Apr 1977).

The interaction of lignite, brown and black coal with molecular oxygen was studied by simultaneous TG and DTA. The experiments were carried out in air. Two programs of controlled heating were used. The thickness of the fuel powder layer was varied from run to run in a ratio 1:2:4:20. Some evidence was obtained that the interaction occurs by concurrent reactions the rate of which is controlled by the composition of the gas phase enclosed in the layer. Reactions of elimination and hydrogen peroxide formation are held responsible for the endothermicity in some stages of interaction. 22 refs.

53692 Self-ignition and mechanisms of interaction of coal with oxygen at low temperatures. III. Changes in the composition of coal heated in air at 60°C. Marinov, V.N. (Energoproekt, Dep of Sci Res, Sofia, Bulg). *Fuel;* **56**: No. 2, 165-170(Apr 1977).

The gradual changes in weight, in elementary composition, in content of oxygen functional groups and in spin concentration have been established for samples of black coal, brown coal and lignite heated in air for a maximum of 1200 h. An intensive oxidative dehydrogenation was found to occur after more than 300 h oxidation. The process was preceded by a decrease in weight and in oxygen content. The acidity ascribed to phenols decreases gradually but it was found to increase at the end of the experiment. A decrease in ignition temperature was established for oxidized black coal, as well as a change in the composition of low-molecular-weight hydrocarbons evolved during the subsequent gradual heating in air. 19 refs.

53693 Interaction between a coke and a tar. II. Limit of tar penetration in coke porosity. Lahaye, J.; Aubert, J.; Buscailhon, A. (Cent de Rech sur la Phys-Chim des Surf Solides, Mulhouse, Fr). *Fuel;* **56**: No. 2, 188-191(Apr 1977).

The limit of penetration of a given coal-tar pitch into two cokes during mixing of the coke and liquid tar has been studied. It was shown that tar penetration is limited by compression of gas occluded in pores. Mercury porosimetry of cokes and pyrolysed coke--tar mixtures as well as micrographs of cokes impregnated with tar allow one to estimate the limiting pore diameter of tar penetration into coke at ca. 6 mum for the system considered. 9 refs.

53694 Minor and trace metal analysis of a solvent-refined coal by flameless atomic absorption. Coleman, W.M.; Szabo, P.; Wooton, D.L.; Dorn, H.C.; Taylor, L.T. (Va Polytech Inst and State Univ, Blacksburg). *Fuel;* **56**: No. 2, 195-198(Apr 1977).

Solvent-refined coals (SRC) have been analyzed for eleven metallic elements via flameless atomic absorption spectroscopy. Prior to analysis each sample was wet ashed with equal quantities of concentrated H_2SO_4 and 30% H_2O_2 Matrix effects were compensated for by the method of standard additions and deuterium-arc background correction. Mg, Al, K and Fe were found in greatest

concentration in all samples. The concentration of Pb and Cd was measurable only in THF-insoluble SRC. 12 refs.

53695 Oxygen in coal ash: a simplified approach to the analysis of ash and mineral matter in coal. Volborth, A.; Miller, G.E.; Garner, C.K.; Jerabek, P.A. (Univ of Calif, Irvine). *Fuel;* **56**: No. 2, 204-208(Apr 1977).

The stoichiometric balance based on analyses of the ashes performed by the USBM is calculated and summations given in oxide and element percent. Excellent agreement is found with the chemical data obtained by classical silicate analysis methods. The complete data provide a quantitative basis for stoichiometric interpretation of coal analyses. It was found that the eight coal-ash samples analysed contained 45.5-3% oxygen. Since these ashes represent a large variety of U.S. coals, this figure can be used as an estimate for recalculation and evaluation of the proximate and ultimate coal analyses. 16 refs.

53696 Material balance in coal. I. Material balance and oxygen stoichiometry of six coals from Wyoming. Volborth, A.; Miller, G.E.; Garner, C.K.; Jerabek, P.A. (Univ of Calif, Irvine). *Fuel;* **56**: No. 2, 209-215(Apr 1977).

Oxygen was determined in six coals from the Wyodak Bed, Campbell County, Wyoming. Data from the U.S. Bureau of Mines' coal analysis reports were used to calculate the material balance of these coals based on accurate oxygen determination by a fast-neutron activation method developed at the University of California, Irvine. A computer program recalculates the data based on moisture and tabulates the results, comparing the 'oxygen by difference' to oxygen determined on 'as received' basis. Oxygen in samples dried at 105$degree$C was also determined in order to estimate the possible effect of oxidation and loss of volatile components other than water during the drying process. Summations of all data were derived using the accurate oxygen values determined. 16 refs.

53697 Polymeric structure of coal. I. Role of ether bonds in constitution of high-rank vitrinite. Ignasiak, B.S.; Gawlak, M. (Alberta Res Counc, Edmonton). *Fuel;* **56**: No. 2, 216-222(Apr 1977).

Results of detailed studies on molecular weights of products from reductive alkylation of high-rank vitrinite are reported. It is concluded that the macromolecular network of vitrinite from a cretaceous bituminous coal is composed of relatively small units which are primarily linked by ether oxygen. A significant portion of these units is characterized by molecular weight substantially below 500. These findings seem to be consistent with results from mild hydrogenolysis and air oxidation of bituminous coals. 17 refs.

53698 Preparation and low-voltage mass spectrometry sensitivities of methylated polynuclear aromatic hydrocarbons. Schiller, J.E. (Grand Forks Energy Research Center, ND). *Anal. Chem.;* **49**: No. 8, 1260-1262(Jul 1977).

The composition of the oil produced by the CO-Steam Process is being studied in detail using mass spectrometry as the primary method. (LK)

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 53653, 53678, 53680, 53813

53699 (FE—2205-6) **Investigation of the mechanism of fly-ash formation in coal fired utility boilers. Quarterly report, February 1—April 30, 1977.** Ulrich, G.D. (New Hampshire Univ., Durham (USA)). 23 May 1977. Contract EX-76-C-01-2205. 11p. Dep. NTIS, PC A02/MF A01.

A summary is presented of the status of this effort and of activities projected to 1979. Laboratory studies are continuing in an effort to formulate a model to describe and predict the growth characteristics of the primary units and aggregates found in submicron, flame-generated particles. More results have been obtained for silica particles at higher temperatures. These data support the previously derived theoretical analysis for fusion-controlled growth and correlate well with earlier low-temperature results. The laser-Doppler technique was employed successfully to measure gas velocities and provide more precise residence times. The measurements revealed a modest radial variation in gas velocity which will be corrected in future burner designs. The Doppler measurements will be used routinely henceforth. Though results for silica particles can be further refined, they are reproducible and precise enough to justify confidence in the experimental system and techniques. During the next quarter, a shift will be made to the study of titanium dioxide which is unexpected to exhibit different growth characteristics because of its much lower viscosity. Plant studies were initiated with five visits to the Merrimack Station, Public Service Co. of New Hampshire. Six samples were collected from the seventh and the fifth floors of boiler unit number 2. Sample collection and evaluation is scheduled to continue through February 1978. Development of the computer program to calculate vapor-liquid equilibria in ash-laden systems is essentially completed.

53700 (GFERC/QTR—77/2, pp 24-32) **Sulfur oxide emission control for combustion of Western U.S. coals.** Sondreal, E.A. Jun 1977.

In Quarterly technical progress report, January—March 1977.

The fly ash derived from many Western coals contains sufficient calcium to react with all the relatively low sulfur content of these coals to form the basis for sulfur emission control. Other alkaline oxides in the fly ash, such as magnesium and sodium, can also contribute to sulfur removal. Studies investigating the utilization of Western coal fly ash alkali in wet scrubbers to remove sulfur dioxide are being performed on a 130-scfm pilot scrubber located at GFERC, and on a 5000-acfm pilot scrubber located at the Milton R. Young Generating Station Center, North Dakota. Tests on the 5000-acfm pilot scrubber conducted under a cooperative agreement were completed in March 1977. Tests on the 130-scfm pilot scrubber were continued using a scrubber solution high in sodium and magnesium. A low sodium fly ash in lieu of high sodium was used to compare sulfur dioxide removal efficiencies and scaling rates. Tests on the 5000-acfm scrubber using low pH to increase the utilization of fly ash alkali were performed using 1000 ppM inlet sulfur dioxide, 80 to 154 gal/1000 acf L/G ratios, and 0.35 to 0.63 CaO/SO_2 stoichiometric ratios. Calculated utilization of calcium varied from 94.2 pct at 0.76 CaO/SO_2 to 214.8 pct at 0.27 CaO/SO_2. Utilization over 100 pct is accounted for by the reaction of cations other than Ca. Tests on the 5000-acfm scrubber using high concentrations of sodium and magnesium were performed using 1000 ppM inlet sulfur dioxide, 10 to 40 gal/1000 acf L/G ratios, and a 0.63 CaO/SO_2 stoichiometric ratio. The sulfur dioxide removal was increased by 10 to 15 pct when sodium levels were increased from 1.3 to about 4 pct; the removal was marginally increased by about 5 pct when magnesium levels were increased from 0.9 pct to about 3 pct.

53701 (GFERC/QTR—77/2, pp 44-46) **Removal of fly ash from stack gases by electrostatic precipitation.** Sondreal, E.A. Jun 1977.

In Quarterly technical progress report, January—March 1977.

Problems are being encountered in the application of electrostatic precipitation (ESP) to the removal of fly ash from powerplant flue gas while burning Western coals. Pilot-scale and laboratory techniques are under development to reduce the uncertainties involved in sizing ESPs for new installations. These techniques can assist in solving problems in existing units as well and answer basic questions concerning ESP operation. Construction was nearly completed on a new 75-lb/hr pc-fired furnace/pilot-scale ESP combination. The purpose of this equipment is to provide a means of burning relatively small quantities of coal and generating fly ash and flue gas representative of that produced when the same coal is burned in a full-scale powerplant. The pilot ESP will allow for comparison of removal difficulty for fly ash from a proposed application with those from installations where ESPs are in operation. The study and comparison of various ESP conditioning agents, as well as some dry SO_2 absorbent schemes, will also be possible. The study and optimization of the use of Nahcolite (naturally occurring $NaHCO_3$) for both ESP conditioning and SO_2 removal is the first test series planned for this equipment. Laboratory capabilities for the study of fly ash properties related to ESP performance are being expanded. The installation of a scanning and analyzing electron microscope has been partially completed and should allow for the study and characterization of single particles down to micron size or smaller. Apparatus and techniques for determining particle size, specific gravity, fly ash resistivity, dielectric properties, and coal and fly ash analysis will act to support pilot plant and field work.

53702 Evaluation of the abrasive properties of nazarovo coal fly ash. Kukuruznyak, A.P.; Olesevich, K.V. (Odessa Polytech Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 67-72(Oct 1976). (In Russian).

Results of an experimental investigation of the abrasive properties of fly ash of Nazarovo coal from Kansk-Achinsk Basin are presented. The possibility of determining the wear of specimens by ungraded ash according to the experimental data, taking into account the fraction content of the fly ash, is demonstrated.

53703 Deep-cone thickeners. *Colliery Guardian;* **225**: No. 1, 20(Jan 1977).

This brief article highlights two developments by the NCB Mining Research and Development Establishment (MRDE) which are designed to improve the landscape around collieries by virtually eliminating the need for settling ponds. Eight deep-cone thickeners were installed at Oakdale colliery, Mid-Glamorgan, to do efficiently a job formerly done ineffectively by two settling lagoons occupying about a quarter acre each. The second MRDE development is an automatic disperser for flocculants, whose hydraulic design prevents clogging by dispersing the flocculant powder as single particles in a rapidly swirling thin film of water.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 53619, 53642, 53645, 53680, 53718, 53720, 53743, 53831, 55065, 55066, 55081

53704 (ANL-K—77-3087-2) **Grundy County demonstration site: phase II. Progress report, 1976—1977.** Green, B.B.; Zellmer, S.D. (Argonne National Lab., Ill. (USA)). Apr 1976. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

Reclamation of abandoned lands has recently become a national issue, primarily with the introduction of federal strip mine legislation. Illinois, like many other states in which coal is mined, has extensive acreages of abandoned mine spoils. The demonstration site selected for this research, located in Grundy County, is approximately 40 miles southwest of Argonne National Laboratory. It is an area of 110 acres, approximately 50 of which were affected by mining and regrading. The mine spoils are adjacent to Goose Lake Prairie State Park, which is receiving acid runoff from the site. In 1972, the Illinois State Department of Conservation purchased the land and commenced regrading the spoils. The regraded site was seeded in 1973 with a combination of prairie and pasture species. All of the site was limed, and some parts were topsoiled. Site surveys in 1975 indicated that approximately 35 acres remained unvegetated. Results are reported on reclamation of the unvegetated areas initiated in the fall of 1975.

53705 (FE—2495-6) **Design and implementation of an environmental monitoring program for ERDA fossil fuel facilities.** Rolan, R.G. (Dalton-Dalton-Little-Newport, Cleveland, Ohio (USA)). Feb 1977. Contract EX-76-C-01-2495. 147p. Dep. NTIS, PC A07/MF A01.

Potential environmental contaminants from coal mining, coal preparation plants, coal liquefaction plants, fossil-fuel power plants and from various auxiliary or subsidiary processes are considered from the possibility of serious environmental impact to the air, water, or biological entities on land. The chemical nature of the various products, by-products and wastes is discussed. For those contaminants (especially SO_2, particles, hydrocarbons, nitrogen oxides, etc.) recognized as having deleterious effects, the regulations involving air quality and emission limits are discussed. Finally, certain contaminants are discussed from the points of view of transport and dispersion in the environment, toxicity, biological accumulation, carcinogenicity, mutagenicity, teratogenicity and other health hazards and potential damage to plants, animals and man and to aquatic ecosystems. The present volume is devoted to identifying the sources of environmental contaminants from ERDA fossil fuel facilities and assessing the hazards. (LTN)

53706 (PB—265316) **The ecological effects of coal strip-mining: a bibliography with abstracts.** Ralston, S.; Hilbert, D.; Swift, D.; Carlson, B.; Menges, L. (Colorado State Univ., Fort Collins (USA). Natural Resources Ecology Lab.). Mar 1977. Contract EPA-16-0008-2107. 421p. NTIS, PC A18/MF A01.

Prepared in cooperation with Environmental Protection Agency, Washington, D.C., as part of the Federal Interagency Energy/Environmental Research and Development Program.

This bibliography contains references with abstracts, on the ecological effects of coal strip-mining in the western United States, with particular emphasis on the Northern Great Plains. It does not represent an exhaustive search of all possible literature, but its board scope will make it useful to workers engaged in stripmine rehabilitation. There are two parts to this bibliography; Part I contains the references and abstracts, Part II is an extensive 'keyword in Title' index to the references.

53707 (PB—265739) **Bibliography of the Environmental Protection Agency's Office of Research and Development energy-related publications.** (Environmental Protection Agency, Denver, Colo. (USA). Office of Energy Activities). Mar 1977. 26p. (EPA—908/4—77/003). NTIS, PC A03/MF A01.

This bibliography consists of a list of publications dealing with energy resource development and its accompanying environmental effects. The publications listed are taken from Office of Research and Development (ORD) publications summaries and from lists provided by the Industrial Environmental Research Laboratory's Resource Extraction and Handling Division.

53708 Rehabilitation potential of western coal lands. Schmidt, R.A. (Electric Power Research Inst., Palo Alto, CA). pp 101-121 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 13. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

Societal concerns over the environmental impacts of surface mining were expressed initially for the Appalachian region where extensive surface mining has been conducted and where the environmental impacts have been substantial, extensive, and adverse. The consequences of surface mining in the East and Midwest have led to intense public concern over the prospective development of western coal fields, resulting in strong impetus for development of rehabilitation techniques that will allow for preservation of the western landscape and prevent a repetition of the Appalachian experience. In the western coal area, complete restoration is rarely, if ever, possible. Reclamation or rehabilitation will depend primarily on the goals and objectives set by society and on the manner in which these goals are implemented by operators and supervised by regulatory agencies. The coal lands of the western states are arid, subject to extreme fluctuations in temperature, characterized by a loose, undifferentiated soil profile with low capacity for holding moisture, high erosion rates, and slow processes of vegetative succession. The arid ecosystems are delicately balanced and, once disturbed, may not reach natural equilibrium on a time scale acceptable to society. Clearly, a range of values and public concerns must become part of the planning for development and rehabilitation.

53709 Environmental viewpoints on mining and transportation of coal. McCormick, J.L. pp 29-41 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

Conservation is an important national goal and beyond conservation, the conversion of gas-fired boilers to coal will free the biggest new supply of natural gas at affordable prices. Importing LNG at $5 per mm Btu or converting coal to synthetic natural gas at $4 to 4.50 per mm Btu offers no real solution. An overwhelming part of the nation's coal reserves must be mined by underground methods because they are too deep to be mined by surface methods. For this reason it is not regarded as wise to let underground mining languish and devote all the coal mining effort to surface mining, since this would soon exhaust the strip minable coal (by soon after 1996) and lead to a rapid decline in surface mining after 2000. It is also recommended that surface mining not be permitted where there is not definitive proof that the land can be reclaimed to a condition suitable for some future useful productivity. The difficulty of successful and viable revegetation is pointed out. A final point is the urgent need to turn the underground coal mining industry around from its rather steady decline. (LTN)

53710 ERDA's impact assessment of gas production. Goldberg, A.J. pp 183-196 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

The goal of the programmatic Environmental Impact Statement for the Office of Fossil Energy is not specificity as one would find in a site-specific impact statement, but rather a search and analysis of the larger effects which, despite the uncertainty of the data and the variability in all parameters, would suggest directions either for new technology initiatives on the part of the Office of Fossil Energy or initiatives in environmental health and safety research and development either in the Fossil Energy Office or elsewhere in ERDA. A corollary of the activity is a systematic identification of environmental health and safety information that might be missing and for which further investigation would be required. The objectives then are: first of all, to describe the environmental effects of the proposed activity, and in this case, the activity covers the full spectrum of all the fossil energy's research; secondly, to look at the alternatives outside the Office of Fossil Energy and within the program; thirdly, to suggest mitigating actions to reduce the potential impacts; and, finally, to provide a body of information so that the federal government, in general, and ERDA, in particular, can have that information as a basis for decision-making about its programs and about its directions. Based on the data we are going to present, we would not propose new technology goals at this time. We would, however, see a serious deficiency in our understanding of some potential impacts, and would recommend strongly that the appropriate R and D efforts be undertaken to clarify those (trace element disposition, effluent compositions, transport and transformation of potentially hazardous substances, dose-response relations, health effects).

53711 Tuesday afternoon roundtable discussion. Hogsett, D. pp 197-218 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

The following items resulted from the panel discussion: objections to refineries and coal conversion plants vary appreciably around the country. Some of the objections are well founded and

should be considered carefully, but the general response to a proposed plant is often negative and difficult to predict. Generally, people like to import clean energy without the environmental effects of producing it. As an example, location of LNG terminal facilities on an island off the California coast was considered to improve safety and minimize site selection problems. The relative prices of natural gas, fuel oil, coal and electricity made from coal and their relative heating value was considered in some detail, including the effects of inflation, of delays in getting coal gasification plants operating and the effects such operating plants would have on natural gas prices, OPEC petroleum prices, etc. The socio-economic factors related to such large plants are discussed, particularly with respect to effects on the Navajos. (LTN)

53712 Mining industry and protection of the natural environment. Stranz, B. pp II.4.1-II.4.9 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

The extraction of mineral raw materials is associated with the place of their occurrence. This exploitation brings about an unavoidable concentration of population, industrial and residential buildings and also the development of communication network in the mining regions and surroundings. Both underground and open-pit mining results in significant alterations of the natural structure of mining areas. The typical consequences of harmful mining activity are as follows: alterations of the surface, associated with devastation of the surface soil (open-pit workings, spoil banks, depressions, etc.); upset of underground and surface water relations (water decay, water pollution, etc.); harm to vegetation (deforestation, degradation of soil fertility; and air pollution (burning spoil banks, etc.). Deterioration of the condition and degree of usefulness of buildings is an adverse effect of the mining activity.

53713 Environmental impact inventory for the Indian mining industry: a forecast to the year 2000 and its implications. Ghose, A.K. (Indian School of Mines, Dhanbad); Bagchi, S. pp II.5.1-II.5.8 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

An attempt is made to identify the dimensions of the environmental problems of the mining industry in India through a mapping of the present and future of the coal and iron ore sectors of the industry. In particular, the problems of the Jharia coalfield with regard to subsidence, mine fires, air and water pollution, are discussed and the likely problem areas for future projected. The analysis shows that the problems would be considerably magnified because of the increased volume of mineral production by the year 2000 A.D., and that the quality of the water environment would be the most crucial area of environmental concern. A scenario identifying priority areas of the mining industry environmental problems is also presented.

53714 Utilization and operational assessment of coal-winning by-products and their significance for environmental protection. Brink, H.J. (Saarland Univ., Saarbruecken, Ger.). pp II.9.1-II.9.7 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

Combined production is one of the hallmarks of the deep-mined extraction of mineral deposits and of their subsequent processing and up-grading. Unused by-products can pollute the environment of a mining company. These negative, external effects lead to social costs which are absorbed internally to a large extent nowadays by the polluter. An exclusively passive compliance with levies and statutory requirements is no longer sufficient; ecological objectives must be integrated into industrial objectives systems. In the long-term, all by-products should be utilized to the full, if we are to come to terms with the acknowledged lack of mineral resources.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 53626, 53783, 54658, 54681

53715 (UCRL—52237) **Geological exploration of potential underground coal gasification sites in the Powder River Basin of Wyoming and Montana.** Qualheim, B.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Mar 1977. Contract W-7405-ENG-48. 67p. Dep. NTIS, PC A04/MF A01.

Information obtained from exploratory drilling of potential coal-gasification sites in the Powder River Basin of Wyoming and Montana is summarized. The objectives were to obtain stratigraphic descriptions of the coal-bearing strata from cuttings and geophysical logs, determine the hydrologic characteristics of the coal and associated strata, and see if there were drilling and logging problems associated with deep, thick coal seams. It was decided to do preliminary hydrologic and gasification experiments on the shallower Felix coal before proceeding to more deeply buried coals. The types of information obtained included geophysical borehole logs, lithologic and stratigraphic logs derived from drill cutting samples, drilling rate data, stratigraphic columns showing the depth and thickness of the coal and associated strata, log analyses showing lithology, computer-generated average porosity, density and velocity, composition diagrams of the geophysical logs run and the lithologic correlations picked from the logs, and coal analysis from selected Felix Coal cores. Specific results are reported in numerous tables, graphs and survey charts.

53716 Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976). 332p. (CONF-770133—).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

This symposium was sponsored by the Division of Industrial and Engineering Chemistry of the American Chemical Society. Twenty-two papers or panel discussions were entered individually into EDB and ERA and eleven into EAPA. The papers deal with the coal deposits and proven reserves of the USA, coal mining production (forecast to 2000), labor relations and personnel training, safety, transport of coal by unit trains and slurry pipelines, US ERDA's coal conversion, fluidized-bed, MHD and demonstration plant programs, coal gasification, coal liquefaction, solvent refined coal, advanced power plants (combined-cycles, fluidized-bed combustion, etc.), and some heart-rending problems experienced by companies proposing coal gasification plants and coal-fired power plants in the southwestern USA due to environmental problems, uncertain and conflicting jurisdiction and changing rules of all the state and federal agencies involved. (LTN)

53717 Economics of coal supply. Falkie, T.V. pp 3-28 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

An overview of US energy problems and policies is presented. As of October 1976, delivered prices per million Btu of fossil fuels at steam electric plants averaged $0.87 for coal, $1.10 for natural gas and $1.94 for oil. The price of oil is more than 4 times that of 1973 and the price of other alternative fuels has more than doubled. Electric power from nuclear power plants is estimated to be modestly lower in cost than that from coal-fired plants (with some reservations about the level of capacity utilization). Certain problems in using coal are discussed. Sulfur content of Eastern coal, transportation cost of Western coal, scrubbers, environmental effects (Clean Air Act), uncertainties in government policies, leasing and mining regulations, productivity of labor, health and safety, etc. The US Bureau of Mines coal research programs are discussed briefly. Coal is regarded as the only real energy possibility and viability of the country to reach a consensus on energy policy is unnecessarily delaying the construction of badly needed energy facilities. (LTN)

53718 Coal utilization in the Midwest. Lundberg, R.M. pp 221-231 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

The coal resources of Illinois are described: 33 billion tons of bituminous coal, with variable but usually too-high sulfur content to burn without washing or scrubbers to control stack emissions. About 82 percent of Illinois coal is used for electric power generation and markets for such use are described and forecast to 1985. Illinois research projects are described: Combined Cycle Turbine Test Facility, Pressurized Fluidized-bed Combustors, and joint programs in liquefaction, gasification and compressed air storage. The USA energy future is discussed briefly: We need to make intelligent use of all options (no one will suffice) and to preserve all available options in spite of environmental, social, technical and legal problems and obstacles. (LTN)

53719 Mineral resources bases of the USSR, the effective methods of utilization of mineral resources. Melnikow, N.V. pp I.16.1-I.16.6 of In Exploitation and beneficiation of mineral raw materials

by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

The Soviet Union has a highly developed mining industry which produces one-fourth of the world output. Annually, the country extracts the largest quantity of coal, iron, manganese and chromium ore, potassium salts, phosphates and raw material for cement production. All types of minerals are doubled every ten years. This development is due to a gradual increase in the reserves of known minerals. During the post-war years, the resources of phosphates, copper, zinc, manganese, nickel, lead, iron, chromium and tin ores, apatites, bauxites and natural sulfur greatly increased.

53720 Protection of mineral deposits in Czechoslovakia. Prazak, J.; Kozisek, J.; Dinka, J. pp II.7.1-II.7.8 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

The rational, economical handling of mineral raw-materials is a basic requirement of the valid Mining Law of Czechoslovakia. The mineral resources of Czechoslovakia are exclusively national property and serve all the people. There is one complete system of regulations to protect the mineral raw-mineral deposits. They ensure the correct exploitation of the mineral resources, and also their protection in view of nonmining activities; furthermore, they also prevent unnecessary damage to other surface buildings and constructions not belonging to the sphere of mining. Some of the specific requirements have necessitated special legal measures.

53721 Using the natural-frequency concept in remote probing of the earth. Lytle, R.J.; Lager, D.L. (Lawrence Livermore Lab., CA). *Radio Sci.;* **11**: No. 3, 199-209(Mar 1976).

A technique is given for determining the thicknesses and the electrical constitutive parameters of a planar-layered medium such as a coal seam in a mine environment. Time-domain experimental data are analyzed with Prony's method to determine the natural frequencies of the layered medium. Explicit relations are given (for dielectric layers) for determining the thicknesses and dielectric constants from the experimentally determined natural frequency results. Explicit expressions are also given (for conductive layers) for calculating the electrical thickness from natural frequency results. The method is illustrated with sample numerical results.

53722 Vale of Belvoir coal reserves. *Colliery Guardian;* **225**: No. 1, 14, 17(Jan 1977).

A report is presented on the investigations carried out so far on the potential of the very large coal reserves recently discovered on the Leicestershire-Nottinghamshire borders. Although exploration and final evaluation of reserves are not yet completed, the full extent of the coalfield is now well defined and its coal reserves are estimated at about 450 million tons.

53723 Recent developments in coal petrophysics. Lavers, B.A.; Smits, L.J.M. (Pet Dev (Oman) Ltd). *Log Anal.;* **18**: No. 1, 6-16(Jan-Feb 1977).

Requirements are given for a suitable package of wireline instrumentation. Qualitative and quantitative interpretations of the logs are discussed. These include control on coring, correlation, determination of ash content, calorific value, rank, identification and characterization of overburden lithologies for mining engineering purposes. An integrated computer system is described to handle coal core analysis and petrophysical evaluation. This is based on a data bank of coal core measurements 'COGEO', a petrophysical interpretation system 'COPLA' and a data bank of interpreted values 'COPET'. A number of application subroutines generate Pseudo-Washability curves and vertical selection for mining feasibility studies. 4 refs.

53724 Coal deposits in the Ukrainean district of Wolhynia. Kuschniruk, V.A. (Wuerzburg Univ. (Germany, F.R.). Inst. fuer Geologie). *Glueckauf;* **113**: No. 5, 279-283(Mar 1977). (In German).

The coal deposit in the West Ukrainean district of Wolynia stretches between the towns Lemberg and Vladimir-Volynskij. The stratified formations come from the Vise, Namur and the Baschkir formations which are assigned here to the lower carbon or middle carbon. Not far from the towns Novovolynsk and Cervonograd, there are about 20 mines hauling gas and fat coals. The heat values are about 8000 kcal/kg; the fat coals are good for coking.

53725 Coal deposits in the Ukranian province Volhynia. Kuschniruk, V.A. (Univ Wuerzburg, Ger). *Glueckauf;* **113**: No. 5, 279-283(3 Mar 1977). (In German).

Geological formations, tectonics, and qualitative evaluation of deposits are presented. 12 refs.

53726 Coal: how much do we really have. How long will it last. Stefanko, R. (Pennsylvania State Univ., University Park). *Earth Miner. Sci.;* **46**: No. 8, 57, 62(May 1977).

The U.S. Bureau of Mines estimates a demonstrated USA coal reserve base of 434 billion tons. Of this, 137 billion tons can be mined by surface mining (recovery 85 percent) and 297 billion tons by underground mining (recovery 50 percent). This translates to a recoverable net reserve of 265 billion tons. But this result could be changed (increased) by the development of new technology or new discoveries. On the other hand, the above reserves, which would last about 380 years at the present rate of usage, would last a much shorter time if the usage rate increased. (LTN)

MINING

REFER ALSO TO CITATION(S) 53706, 53712, 53713, 53714, 53716, 53717, 53718, 53719, 53720, 53722, 53796, 53820, 53827, 53828, 53829, 53830, 53831, 53832, 53834, 53835, 53836

53727 (CONF-7603103—1) Coal mine development financing during the next decade. Wilson, W.W. (Continental Illinois National Bank and Trust Co., Chicago (USA)). 1976. 14p. Illinois National Bank and Trust Co., Chicago, IL.

From 2. coal conference; New Orleans, Louisiana, United States of America (USA) (10 Mar 1976).

Rapidly escalating prices for mining equipment and services during the last several years have doubled and tripled some costs of coal development, and some of the older estimates of coal's capital requirements are now much too conservative. Another problem with virtually all of these studies is the general unavailability of complete and reliable statistics on the total industry's previous capital investments, mining capacity and earnings, in order to have meaningful starting points for the projections. It is scarcely surprising, therefore, that the forecasts of the coal industry's future capital requirements for Project Independence and comparable scenarios, even when adjusted to a uniform ten-year time frame of 1976-85, cover a wide range from nearly $11 billion to about $25 billion, expressed in either 1974 or 1975 dollars. 17 references.

53728 (PB—266060) Parametric study of coal cutting with the CAVIJET (trade mark) cavitating water jet method. Final report 11 Jun 75—7 Sep 76. Conn, A.F.; Rudy, S.L. (Hydronautics, Inc., Laurel, Md. (USA)). 30 Sep 1976. Contract H0252025. 156p. NTIS PCA08/MF A01.

This report describes the first phase of a developmental program, which has the ultimate objective of design, fabrication, testing, and evaluation of coal cutting equipment which uses the CAVIJET cavitating water jet method. The CAVIJET is one of the very few successful applications, for useful purposes, of the destructive power of cavitation. Suitable design of the CAVIJET nozzle and supporting hydrodynamic components causes enhanced growth and collapse of the 'nuclei' (vapor-filled cavities) in ordinary water, thereby concentrating energy to create extremely high, localized stresses at the surface to be cut, drilled, or cleaned. This local amplification of pressure provides the CAVIJET with inherent advantage over a noncavitating jet, and in each of the prior applications which have been studied, the CAVIJET method produced comparable or better results at a considerably lower pressure and power. Prior uses include: clearing barnacles and rust; missile propellant removal; cutting of concrete, rocks, and ice; and bark removal.

53729 (PB—263731) Automatic face transfer linear cutting rotary head continuous mining machine. Roepke, W.W.; Lindroth, D.P.; Wilson, R.J. (Department of the Interior, Washington, D.C. (USA)). 15 Oct 1976. 14p. NTIS, PC A02/MF A01.

A coal mining apparatus and its method of use in which a continuous mining machine removes and transfers cut material reducing airborne respirable coal dust generated in the cutting and collection process. The conventional high speed head rotating with the bits going forward at the top is replaced by a triangular shaped dished out linear cutting head rotating with the bits mounted at the apexes going rearward at the top. This produces a box cut in the mine face with a square cross-section. After the head has made a box cut by sumping the full head diameter beginning at the mine floor, it is sheared upwardly producing a linear shear cut. This shear step is at a constant depth equal to the complete cutting head diameter. The modified cutting head is used as part of the loading and transfer mechanism.

53730 (PB—265178) Test program for automatic steering shuttle car. Final research report 1976. Troyer, M. (Bendix Corp., Denver, Colo. (USA). Energy, Environment, and Technolgy Office). Jul 1976. Contract J0155048. 76p. NTIS, PC A05/MF A01.

A coal shuttle car equipped with a pulsed laser optical ranging system to provide guidance for an automatic steering system was tested in production coal mining. Test results are presented for the

two mines where testing took place, and some operator's reactions are included. Automatic steering control keeps the car centered in an entry, and automatic turns are made at intersections as signaled by the operator. All other controls, tram, conveyor, brake, etc., remain manual and require operator control. Complete override of steering while in the automatic mode is retained by the operator, who may grab the steering wheel at any time and turn in opposition to the automatic signal by applying about 10 foot-pounds of torque.

53731 (PB—265179) **Feasibility of automatically steering low coal shuttle car. Volume II. Final research report 1976.** Rybak, S.C.; Headley, R.P. (Bendix Corp., Denver, Colo. (USA). Energy, Environment, and Technolgy Office). Jul 1976. Contract J0155048. 130p. NTIS, PC A07/MF A01.

An automatic steering system for a coal shuttle car was tested in production coal mining situations. The system uses a pulsed laser optical ranging system to provide guidance information. Automatic steering control keeps the car centered in an entry with automatic turns being made at intersections as signaled by the operator. The operator can override automatic steering at any time by using the steering wheel. All other controls remain manual. The feasibility of using the existing automatic steering system hardware on a low coal shuttle car with physical dimensions and control characteristics differing from those of the test car was demonstrated through analysis and simulation. Results are presented showing operation of the automatic steering system on a low coal shuttle car is feasible in 19-foot entries with some changes in the gain values in the control loop and with relocation of the lateral sensors. Acceptable operation in 18-foot entries is demonstrated with the addition of steering command delays for low-speed running and a change in sensor location in addition to the gain changes mentioned previously.

53732 (PB—265185) **Exploration of illumination concepts for underground coal mines. Final report.** Williams, L.A.; Aiello, S.J. (Crouse-Hinds Co., Syracuse, N.Y. (USA). Construction Materials Products Div.). Oct 1976. Contract H0220065. 148p. NTIS, PC A07/MF A01.

The report documents the results of an investigation of lighting system modifications and designs for working place illumination in high and low coal entries of underground coal mines. The portable and machine mounted system designs, both modified and prototype, represent a continuation of work performed under Contract No. H0111403. See the Final Technical Report dated May 26, 1972, for detailed information concerning this prior contract. All modified and prototype systems met the performance requirements of Bureau of Mines specification 2G, as proved by test. In addition, the systems met the requirement for illumination, as specified in the contract and in the proposed standards which were generated in response to Public Law 91-173.

53733 (PB—265186) **Exploration of illumination concepts for underground coal mines. Appendix D. Design drawings. Final report.** Williams, L.A.; Aiello, S.J. (Crouse-Hinds Co., Syracuse, N.Y. (USA). Construction Materials Products Div.). Oct 1976. Contract H0220065. 184p. NTIS, PC A09/MF A01.

The appendix contains drawing lists and drawings of components and assemblies designed for the prototype portable and machine mounted lighting systems for tasks II and IV of Contract No. H022065.

53734 (PB—265187) **Exploration of illumination concepts for underground coal mines. Appendix E. Electronic ballast for the Lucalox high pressure sodium lamp. Final report.** (General Electric Co., Danville, Ill. (USA). Ballast Business Dept.). 20 Jul 1976. Contract H0220065. 131p. NTIS, PC A07/MF A01.

The report documents the results of an investigation to develop solid-state ballasts for Lucalox high-pressure sodium lamps. The ballasts were to be used in the modified and new portable and machine-mounted lighting systems designed by the Crouse-Hinds Co., per tasks I through IV of Contract No. H022065.

53735 (PB—265365) **Constitutive relations of coal and coal measure rocks. Interim Report 1 Jan 75-30 Jun 76.** Ko, H.; Gerstle, K.H. (Colorado Univ., Boulder (USA). Dept. of Civil, Environmental, and Architectural Engineering). Aug 1976. 262p. NTIS, PC A12/MF A01.

The properties of coal from the Pittsburgh seam, procured from the Bruceton and Federal No. 2 mines, were found to be similar. Strength and stiffness properties of Behive mine coal were determined, and the material was found to be isotropic. Mechanical, index, and geologic properties of roof and floor coal measure rocks from Beehive mines were measured and correlated. Analytic formulations are given for coal creep under uniaxial loading, while triaxial creep is being investigated. Results of testing of coal model structures are compared with predictions from using several material models.

53736 (PB—265617) **Basic estimated capital investment and operating costs for underground bituminous coal Mines developed for longwall mining. mines with annual production of 1.3 and 2.6 million tons by longwall mining from a 48-inch coalbed. Information circular.** Duda, J.R.; Hemingway, E.L. (Bureau of Mines, Morgantown, W.Va. (USA). Process Evaluation Group). Dec 1976. 29p. (BM-IC—8720). NTIS, PC A03/MF A01.

See also PB-248 967.

This study estimates the required capital investment, operating costs, and selling prices for two hypothetical mines designed to produce 1.3 and 2.6 million tons per year (MMtpy) by using a longwall system in conjunction with a continuous-mining system. The coal properties being mined are assumed capable of supporting a 20-year production period. Wages and union welfare payments used in this study are those in effect Dec. 5, 1975, as set forth under the National Bituminous Coal Wage Agreement of 1974. Costs of materials and equipment are based on January 1976 indexes.

53737 (PB—265934) **Nonclogging water spray system for continuous-mining machines: installation and operating guidelines. Information circular, 29 Jun 73-1 Jun 76.** Divers, E.F. (Eastern Associated Coal Corp., Everett, Mass. (USA). Dept. of Research and Development). 30 Sep 1976. 16p. NTIS, PC A02/MF A01.

See also report dated Nov 75, PB-250 626.

A new nonclogging water spray system for continuous-mining machines has been developed under contract with the Bureau of Mines. This paper presents installation and operating guidelines for the system, which consists of improved and easily maintained machine-mounted hardware, including an inline Y-strainer, a hydrocyclone, a backup filter, and two quick-opening valves for flushing particulate from the strainer and hydrocyclone. Underground tests with continuous-mining machines have shown that when properly installed and maintained, the new system virtually eliminates nozzle clogging and thus greatly reduces spray maintenance. The system is relatively inexpensive and has been installed on typical continuous-mining machines for a total cost under $1,000.

53738 (PB—266086) **Technical services for mine communications research. Task II. Longwall mining communications. Final report Jun 75—Sep 76.** Roetter, M.F.; Emslie, A.G.; Lagace, R.L.; O'Brien, P.F. (Little (Arthur D.), Inc., Cambridge, Mass. (USA)). Sep 1976. Contract H0346045. 62p. (ADL-C—78451-F). NTIS PCA04/MF A01.

The communications requirements and need for communications, both for voice and control, in U.S. longwall coal mines are analyzed and recommendations made to guide the future development and design of longwall communications equipment and systems. Information on a wide variety of longwall environments is presented as obtained from visits to, and contacts with a number of longwall mine operators and equipment suppliers both in the United States and in Europe. The value and role of communications equipment in increasing productivity and safety in longwall mines are described. Recommendations are formulated for improved face pager phones, where it is possible to use existing European equipment and for the development of UHF and/or LF radio equipment for voice communications, as well as of VHF radio for remote control of shearer mining machines. Approaches to the remote operation of roof support, conveyor advance, and the maintenance of face alinements are also discussed. Areas where fruitful development work is already underway are distinguished from areas which could benefit from new initiatives.

53739 (PB—266605) **Remote sealing of mine passages containing flowing water.** Maser, K.R. (Department of the Interior, Washington, D.C. (USA)). 4 Jan 1977. 4p.

Supersedes PB—245352.

Underground passages having water flowing therein are sealed remotely from the surface by first emplacing an aggregate layer on the passage floor through a borehole to a depth sufficient to allow the flowing water to percolate through the aggregate without overflowing it. Fly ash, either alone or admixed with cement or a swelling clay, is then pneumatically injected into the passage atop the aggregate. Finally, water flow is closed off by injecting a cementitious grout into the aggregate layer.

53740 (UCRL—79145) **Study of coal mine roof behavior during mining.** Langland, R.T.; Owens, J.K.; Dixon, J.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Jan 1977. Contract W-7405-ENG-48. 29p. (CONF-770312—2). Dep. NTIS, PC A03/MF A01.

From Annual AIME meeting; Atlanta, Georgia, United States of America (USA) (Mar 1977).

The U.S. Bureau of Mines has conducted underground tests and computer analyses to study coal mine roof behavior. Southern Ohio Coal Company provided test sites in their Meigs mines located near Albany, Ohio. Testing apparatus was adapted for monitoring roof behavior at the face of mining from a remote surface location. Finite element analyses were applied to study the structural conditions present. Test sites were located at three different intersections of entries and crosscuts of the room-and-pillar mine. Electrical readout instruments were used to record roof bolt loads, roof sag, and

roof-floor convergence. They were installed during the roof bolting cycle of a conventional mining section and data was recorded for several months. Normal mining operations continued throughout the test period with minimal interruptions due to the installation and monitoring of the instruments. A computerized data acquisition system, partly underground, partly on surface, permitted continuous monitoring of data and its retrieval, display, manipulation, and storage. The finite element code used to model the test sites accounted for three-dimensional geometry, nonlinear material behavior, and the mining excavation and bolt installation sequences. Results of the test are highly variable. Comparable values between test and analysis results were obtained by applying statistical averaging of roof test data. Results of the analyses indicate that bolts have a lesser effect on the gross behavior of mine roofs than has been indicated and that bolt load changes are strongly influenced by mining excavation sequence, bolt-placement sequence, and face distance.

53741 Mine face hydraulic transportation. Shock, D.A. (Continental Oil Co., Ponca City, OK). pp 77-81 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

It has been long recognized by the coal mining industry that after the development of the continuous miner, the production rate from the mine was restricted mainly by the various interface operations involved with moving the coal from the face to the outside of the mine. With the CONOCO-CONSOL technological base of experience in slurry transport, serious research effort began in 1969 to design a system which would handle "run-of-mine" coal from a continuous miner. An evaluation of the requirements of the system were that: (1) the transport system approximately match the capacity of the continuous miner, (2) the top size should be as large as economical within the limits of hydraulics, (3) the system be extensible to follow behind the continuous miner and the advance of the extraction system, and (4) the equipment be of such size and mobility to be capable of use in a large percentage of the Pennsylvania-West Virginia reserves. The design and development of the components and subsequent testing was accomplished in several evolutionary steps.

53742 Improved mining systems. Schmidt, W.B. (Bureau of Mines, Washington, DC). pp 87-99 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

The Bureau of Mines has been given the responsibility for the Federally funded effort for the development of coal mining technology. This program is separate from the Bureau's coal mine health and safety research program, although the results of that program are necessarily closely integrated with our new program. We are giving all possible attention to providing technological improvements which can be accomplished to assist in the solution of coal production problems which the industry is expected to face in the next 10 years. Our near term effort is necessarily directed to stimulating the introduction of improved technology which is either available now or can shortly be made available to the coal mining industry. This includes imported technology, promising technologies in the development stage and items which have been tried in the past and deserve another look. Our intermediate to long term efforts are directed to increasingly sophisticated systems which promise much greater improvements.

53743 Land and natural resource information and some potential environmental effects of surface mining of coal in the Gillette area, Wyoming. Keefer, W.R.; Hadley, R.F. Washington, DC; Geological Survey (1976). 33p.

An integrated program of geologic, hydrologic, geochemical, and related studies by the U.S. Geological Survey in central Campbell County provides basic information about the land and its resources, including characteristics of the landscape, properties of rocks and surface materials, depth and thickness of coal, streamflow, depth to ground water, quality of ground water, sediment yield, concentrations of trace elements in soils, rocks, coal, vegetation, and water, and current land use. The data are used to analyze and predict some of the potential environmental effects of surface mining, such as the extent of land disturbance, nature and degree of landscape modification, and disruption of surface-water and ground-water systems. Refs.

53744 Constraints to the expansion of coal mine production. Quenon, R.H. pp 58-69 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

Since the USA reserves of natural gas and oil are only 13 percent of our total energy reserves but are supplying 74 percent of our present energy consumption, while coal with 83 percent of our proven recoverable reserves supplies only 18 percent of our present demand, it is apparent that a major change in our energy consumption patterns must occur in the near future. By 1990, it is estimated, on the basis of a forecast by Exxon Corp., that we will need to mine 1,500 million tons of coal per year. This will require a major effort which is outlined: total energy expenditures must nearly triple (from $10 billion per year to $28 billion); 210 new coal mines of 5 million tons per year must be developed with a lead time before production of 5 to 10 years, allowing for the retirement of present workers, more than twice the present labor force must be recruited and trained. Although this involves a major effort it is regarded as feasible unless there are problems with respect to: capital availability (horizontal divestiture may hurt); environmental problems (land reclamation, Clean Air Act, etc.); or legislative or legal problems (court suits, legal ambiguities, etc. may cause delays or even discourage large investments). A balanced program is advocated with the major production increase in the West, but some increase in the East, with government and industry working together cooperatively, and a sensible balance between the environment and economics. (LTN)

53745 Labor-management relations in the coal industry. Brennan, J. pp 71-78 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

Health and safety in the USA coal mines must be improved with the industry, unions and government all working together to minimize accidents, improve training, etc. Improved productivity is necessary and union cooperation is a necessary factor. Employment stability without strikes will benefit both the industry and the union. Unions and management will always disagree over many subjects, but such disagreement has to be carried on within an overall environment of mutually acceptable goals. (LTN)

53746 Coal utilization in the West. Landers, W.S. pp 248-259 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

The proven coal reserves in the western USA recoverable by present technology amount to 122 billion tons, about half recoverable by surface mining and half by underground mining. The location and type of the major deposits are given. Coal production in the western area is given from 1940 to 1973 and projected to 1985. The majority of this coal is used for internal area electric power generation, but increasing amounts are exported to other areas and about 5 million tons per year is used for other internal purposes. Major increases in production are projected, which will be much greater if there are further delays or cancellation of proposed nuclear plants. The author does not expect export to other areas to increase as rapidly, since the cost of railway transport for 1000 miles is approximately 6 percent of the energy transported (coal liquefied to diesel fuel at 50 percent efficiency) and scrubber energy usage represents 5 to 13 percent of the energy in the fuel burned, but this is expected to decrease to the point that scrubbers and high sulfur local coal represents a better compromise in eastern states. (LTN)

53747 Coal: an assessment of the opportunities and challenges. Zeren, R.W. pp 295-303 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

Projections imply that the coal needed for electric utilities in 1985 will be double the 447 million tons used in 1976, and will double again by 2000. At this latter rate the USA has less than 100 years of proved reserves. Further, there may be transportation problems, air and water quality problems, etc., in using coal at this rate. It is predicted that most utilities will be using pulverized coal boilers with flue gas scrubbers by 2000. A few advanced possibilities look attractive, but the time and expense of pilot plant testing and commercialization will prevent a major change by 2000. The attractive possibilities listed are: Fluidized-bed combustion, advanced coal gasification with combined-cycle power plants and coal-derived liquids (if the price is right, the amount of usage is very sensitive to the price). If we resolve environmental problems, technical and business risks and who pays for them, there will be a potential for great growth in new technologies proven by 2000. (LTN)

53748 Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976). vp. (In Several Languages). (CONF-7605143—).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

Separate abstracts were prepared for 18 papers presented at the meeting.

53749 Vigorous growth of the coal industry south of the Yangtze. pp I.14.1-I.14.6 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

People in the nine provinces south of the Yangtze in China, under the guidance of Chairman Mao's revolutionary line launched a stirring mass campaign to search for coal and open up mines. Hundreds of millions of masses bringing their inexhaustible wisdom and power discovered coal deposits of industrial value in over 60 percent of cities and counties, and opened hundreds of thousands of medium and small sized coal mines. This has, in great extent, changed the distribution of the coal industry and has made great contributions to development of local industries and agriculture and to the improvement of livelihood of people, urban and rural. It is proved by practice, that the key to progress for developing countries nowadays, is to develop national economy in the spirit of self-independence and self-reliance by utilizing indigenous resources.

53750 Efforts towards the humanization of working conditions in West German coal mines. Kegel, H. (Ruhrkohle Aktiengesellschaft, Essen). pp II.11.1-II.11.13 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

A discussion is presented on the principal efforts aimed at creating more humane working conditions in West German coal mines. The initial impetus for the most recent activities was the Federal Government's Action Program for the Humanization of Working Life, the first step in the program being the prevention of accidents at work and occupational illnesses. The situation regarding accidents and illness in the West German coal mining industry confirms the success of the measures effected by legislation and by companies on their own initiative in collaboration with employees' representatives. Also presented are further activities aimed at improving working conditions, namely research and development projects in the fields of ventilation, gas expulsion, climatic problems, combating dust and silicosis, and work safety and ergonomics. All these activities aim at contributing to making conditions for people at work more humane, in order to guarantee their physical, mental, and social wellbeing and to contribute to a technically and economically rational harmonization of human and mechanical labor. For humanization and rationalization do not conflict with one another but rather complement and support each other snce they are measures that are needed simultaneously, on the one hand to improve the nature of, and on the other hand to economically safeguard the jobs of those employed in the West German mining industry.

53751 Rock bursts and possibilities of their prevention. Sebor, G.; Rudajev, V.; Simane, J.; Rocek, V. pp II.14.1-II.14.12 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

When evaluating the condition of the rock mass from the viewpoint of the danger of its sudden failure in the rockburst-exposed mining areas of Czechoslovakia, a time anticipation of the occurrence of rock bursts, enabling the timely and adequate technical measures for the reduction of their consequences, is aimed at. The local prediction is based upon laboratory testing of the tendency or rocks towards bursting phenomena. The time predictions are based on the measurements, in situ, mainly of the seismic, seismoacoustic, and convergence data. The complex evaluation of the gathered data is used as basis for the realization of protective measures.

53752 Planning and exploitation of high production faces in deep coal seams liable to bumps. Singh, R.D. (Indian School of Mines, Dhanbad). pp II.20.1-II.20.9 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

Problems of coal mining at depth are discussed. Basic methods for forecasting bumps in coal mines are presented and active control measures described. Methods for planning of optimum workings in coal seams liable to bumps are given. Experiences of mining Disergarh Seam are outlined.

53753 Pre-development decisions in the mines of the Campine Coalfield. Lemaitre, P.M.J. pp III.5.1-III.5.8 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

A description is presented of the manpower deployment system in connection with the particular example of the formation of shift teams in the mines of Limburg, in Belgium. Teleprocessing, an information-management system and a conversation-mode link to the computer give all the officials, from overman to engineer, accress to the system, thus enabling it to serve as support for a large number of decisions at both management and foreman level.

53754 Planning for development of a high-capacity combined mine for working deep and thick seams. Niyogi, H. (Tata Iron and Steel Co. Ltd., Jamodoba, India); Ghose, A.K. pp III.13.1-III.13.16 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

An attempt has been made to highlight some of the principal factors considered in planning for the development of a combined mine for a daily production of 5500 tons in Jharia Coalfield (India) for exploiting deep and thick coal reserves. An outline of the mine model chosen for this rationalization program, which involved the amalgamation of three existing mine units with fairly dispersed reserves, is presented. The problems of exploiting thick and contiguous seams, and of seams already developed on pillars, are discussed and proposals for new methods are mooted. The choice of the level of mechanization, keeping in view the economics of application and the need for trained manpower, is also examined.

53755 State and development of modern open-cast mining technologies in the G.D.R. Koziol, G. (VVB Braunkohle, Senftenberg, Ger.); Strzodka, K.; Eidner, G. pp III.22.1-III.22.10 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

The state and development of modern opencast mining technologies in the G.D.R. are featured by an increased concentration of mining enterprises and the use of highly productive overburden conveyor bridges handling overburden of more than 60-m thickness as well as modern large-size equipment combinations. The growing auxiliary and secondary processes have to be streamlined, and intensification of all the processes as a whole has to be increased continuously by utilizing science and technology. Based on approved long-term programs the lignite industry will develop as the most important primary energy supplier for the present and the future.

53756 Testing and assessment of the F6-Hk heading machine. Bocsanczy, J. (Technical Univ. of Heavy Industry, Miskolc, Hungary). pp IV.8.1-IV.8.12 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

For some considerable time in the past, the F-tunnel heading machines have been in operation in Hungarian mines. Prior to the further development of the F6-Hk machines, currently being built, tests and measurements were carried out under operating conditions. In doing so, it was concluded that the design of the machine required a modification. The motor rating of the built-in cutting head was not adequate and the stability of the machine, especially when overloaded, left much to be desired. Taking into account the proposed modification, it is possible to achieve with a 60 kW cutting head motor rating a cutting performance of 20 to 25 m^3/h in a rock having a compressive strength of 6000 N/cm^2, the figure at 3000 N/cm^2 compressive strength being 40 to 45 m^3/h. The study also comprised other modifications. Of particular importance is the design of the technological mechanization chain, whose task it is to ensure the interplay of the various processes.

53757 Boom-type continuous miners in North America. Schenck, G.H.K. (Pennsylvania State Univ., University Park); Kogelmann, W.J. pp IV.9.1-IV.9.12 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

Different utilization of boom miners in North America compared to Europe is the focus of this paper. The technical advantages of the point-attack cutterhead are discussed based on rock cutting theory. The relative merits of various cutting and loading systems are pointed out along with information as to design improvements based on American use. Examples of best practice application of boom miners are provided from selected mining and construction projects.

53758 Use of resin anchored bolts in mine roofs. Stouls, M.L. (Titanite Explosives Co., Pontaillr-sur-Saone, France). pp IV.22.1-IV.22.10 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

In all underground workings, roof and side support is designed to restrict rock movement. Resin held bolting, a new technique, is beginning to replace all other forms of support. After describing the various methods in use, we shall explain the principle of resin bolting, its advantages, its practical application and its comparative results. Finally, current achievements and their essential characteristics are discussed.

53759 Profile of basic engineering specializations for modern mining and post-graduate improvement of the engineering staff. Ney, R. (Academy of Mining and Metallurgy, Krakow). pp V.3.1-V.3.6 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

The actual situation in the mining industry is described; its role in the development of world economics (off-shore mining especially) and the foreseen directions of mining development, determining the mining engineering education profile, are presented. The engineering need, mining staff education based on the newest science and world technology achievements, is emphasized with a vision of the year 2000. Because of a rapid growth of new ideas in particular science branches, the necessity for post graduate improvement of mining engineers along with their work arises. This process is foreseen with close collaboration of science and industry.

53760 Conditions of maintenance and methods for protection of intakes in the pit bottoms in Rybnik coal area mines. Kostrz, J. *Przegl. Gorn.;* **32**: No. 10, 441-444(Oct 1976). (In Polish with English abstract).

Causes of damages to intakes in the pit bottoms and rooms are given, and steps taken to eliminate or reduce then are described.

53761 Assessment of workability of dirt partings in coal seams of the Lublin coalfield. Wojnar, W. *Przegl. Gorn.;* **32**: No. 10, 452-457(Oct 1976). (In Polish with English abstract).

On the basis of results of laboratory tests, geotechnical parameters of dirt partings in coal are examined. The hardness of dirt partings reaches sometimes considerable values which, in certain areas and coal seams, may render difficult the mechanization of working. Results of tests of the Lublin Coalfield are compared with those of the Upper Silesian Coalfield. 9 refs.

53762 Recent coalmining developments in Britain. Dunn, R.B. (Natl Coal Board, Engl). *Aust. Min.;* **68**: No. 12, 22-24(Dec 1976).

The emergent specialism during the last two decades of coalmining in Britain has been the longwall face mechanization program, and the mechanization engineer now has a prominent place in the industry's technical and management structure. More recently, some of the techniques employed have been modified for use in the drivage of underground roadways to meet the needs of faster extraction, and in pa particular to allow the industry to develop its potential for retreat methods of working where mining conditions are suitable.

53763 Five years of operating experience with 950-volt continuous miners. Cairns, R.A. (Aust and Steel Pty, Ltd). *Min. Congr. J.;* **63**: No. 1, 54-58(Jan 1977).

Bord-and-pillar systems, using continuous miners and shuttle cars, are the principle mining methods in Australia, and in the past all of this equipment has been supplied at 415 volts a-c. In 1965, longwall equipment designed for 1100 volts was introduced and statutory regulations which had previously been adequate for voltages up to 600 a-c had to be reconsidered. These regulations were available as a reference when 950-volt machines were proposed. The application of these machines has been an unqualified success and the claims made in 1971 in terms of increased operator safety and productivity, machine availability and lower maintenance costs have been completely vindicated. Of the 230 continuous miners in service in Australia, some 130 are 950-volt machines, and with few exceptions mining companies are specifying 950 volts on all new machines.

53764 Safe transportation system with diesel trolleys in the North Rhine-Westphalia coal mines. Hoischen, G.; Hackenberg, W. *Glueckauf;* **113**: No. 2, 59-64(20 Jan 1977). (In German with English abstract).

Safety aspects of trolleys are discussed, and results of systematic experiments under various operating conditions are evaluated. Means of explosion and fire protection are described, and a new rail suspension is introduced. Increase in transportation volume is noted. 11 refs.

53765 New concepts for full face heading machines. Horst, H. *Glueckauf;* **113**: No. 2, 70-73(20 Jan 1977). (In German with English abstract).

Economic advantages and technical difficulties of concept are analyzed. Large diameter machines, new support techniques, organizational tools, standardization, and planning are discussed and compared. 1 ref.

53766 Development and examination of a new gliding plow at the mining technique experimental site of 'Bergbau-forschung', Ltd. Henkel, E.H.; Wildfoerster, H. *Glueckauf;* **113**: No. 2, 73-79(20 Jan 1977). (In German with English abstract).

New device incorporating advantages of plow with baseplate and guided on a gliding track, is described. Track covers full width of conveyor. Cutting and pressure controls results are compared with those of earlier types not having combined construction. 10 refs.

53767 South African coal industry sees significant expansion. Holz, P. *Coal Min. Process.;* **14**: No. 2, 71-74(Feb 1977).

A current expansion by Witbank Colliery Ltd., a coal mining firm in the Eastern Transvaal, is highlighted. The expansion, which comes in the wake of a contract signed with Japanese steel interests, will increase the company's annual output from 5.2 million tons of coal to 17.5 million tons. A coal crushing and washing plant which will meet the contract requirements for supply of a low-ash blend coking coal is also briefly described.

53768 Wide web shearing at Hatfield Colliery. Pearey, J.T.; Bumstead, W.E. (Natl Coal Board, Doncaster Area, Engl). *Min. Eng. (London);* **136**: No. 189, 243-256, 276(Feb 1977).

The authors explain the need to maximize the depth of web obtained from mechanized units and describe a face design which is an attempt to obtain 36 in. within the normal 6 ft 6 in. prop-free front distance. Further details are given of the surface trials at Hatfield Colliery and subsequent underground operational experience incorporating the horizontal version of the Rack-a-Track chainless haulage system working on a 1 in 5 gradient. The results obtained from both facets of the exercise are given and the authors conclude that an extension to wide web shearing and probably buttock type mining is foreseeable.

53769 Design loads for gateside packs and support systems. Whittaker, B.N.; Woodrow, G.J.M. (Univ of Nottingham, Engl). *Min. Eng. (London);* **136**: No. 189, 263-275(Feb 1977).

The purpose and application of gateside packs are reviewed and an account is given of the more important practical implications of layout, position and type on immediate roof control and gate roadway stability. Pack design loads are examined in detail. A concept of pack loading by a detached roof block, the size of which has been established by underground measurement and scientific derivation, is discussed. Practical application of the results is described in relation to design of gateside pack support systems. 10 refs.

53770 MRDE's contribution to technological progress at the coalface. Tregelles, P.G.; Hartley, D. (Natl Coal Board, Min Res and Dev Establ). *Min. Eng. (London);* **136**: No. 189, 277-286(Feb 1977).

Technological progress at the coalface, made thanks to the efforts of the National Coal Board's Mining Research and Development Establishment, is reviewed. The paper looks at problems at the coalface and draws conclusions for conditions in the U.K. These conclusions are that concentration of output on to a lower number of faces is essential if productivity of plant and of men is to increase, and that the present systems have sufficient slack within them to produce the results needed in the early 1980s.

53771 Powered roof supports. Arnott, L.J.; Thompson, E. (Gullick Dobson Int). *Colliery Guardian;* **225**: No. 2, 96-99(Feb 1977).

Powered roof supports were introduced into British coal mines in the mid 1950's. Today's heavy duty designs have been developed from the simple designs of 21 years ago and are based on experience gained in a wide variety of mining conditions during this time. Control systems for powered roof supports have been developed to a stage where suppliers can offer from simple unit control of

individual supports to sophisticated remote control of multiple units and this paper outlines progress of roof support development with particular emphasis on developments applicable to the mining industry of the United States.

53772 High-output longwall face coalbrook collieries South Africa. Wilkin, G. *Colliery Guardian;* **225**: No. 2, 101, 103-104(Feb 1977).

A description if presented of the role of Eickhoff coal getting and conveying equipment in the development of a high output longwall face at Coalbrook Collieries in South Africa. The Eickhoff face equipment was obtained to prove the economic benefits of longwall-mining at the colliery. The mining machine used on this high-output face is an Eickhoff double-ended ranging drum shearer, powdered by two 300-kW motors.

53773 Trials with the B.J.D. in-web shearer at East Hetton Colliery. Brown, P.G. (Natl Coal Board). *Colliery Guardian;* **225**: No. 2, 106-112(Feb 1977).

East Hetton Colliery--one of the few remaining working collieries in the South West section of the Durham coal field--was sunk in 1836. The remaining reserves are completely surrounded by abandoned collieries and to a large extent are either overworked or underworked by other now exhausted seams. The author describes trials with the BJD In-web shearer at this colliery in the NCB North East Area. The trials of this shearer have established that it is possible to aim for a 760 mm (30 in.) web. The average advance achieved at East Hetton was 700 mm(27.5 in.).

53774 Underground coal mining research and development. Frantz, R.L. (Pa State Univ, University Park). *Min. Congr. J.;* **63**: No. 2, 77-82(Feb 1977).

A review if presented of activities in mine development, extraction systems, roof support, materials handling and haulage, electrical power systems, monitoring and communication systems, illumination, respirable dust controls, ventilation, methane drainage, training and systems analysis.

53775 Surface coal mining--1976. Eadie, G.R. (Indiana State Univ, Evansville). *Min. Congr. J.;* **63**: No. 2, 114-116(Feb 1977).

Although no radically new piece of equipment was developed during 1976 that will change the surface mining industry, there are several experiments of interest. The environmental clout has generated interest in reclamation equipment development. The handling of topsoil has taken a new dimension for many operators who have needed help in meeting legal reclamation requirements. Purchase lead time required has been reduced for equipment. The technology advances in surface mining in 1976 were those brought about by the pressure of production demands.

53776 Inflow of methane in case of pressure differences at the stopping. Noack, K.; Stegmanns, W. *Glueckauf;* **113**: No. 3, 121-123(Feb 1977). (In German).

A report is given on an unusual increase of the methane content in the current of air of a longwall face, whose cause appears to be in mountain movements. The precautionary measures met, the measuring system for pressure difference and methane content as well as measured results are given. It is shown that the conventional monitoring of stopping dams with differential pressure recorders, at least at merely small differential pressures, do not allow a definite statement to be made on the flow direction. In such a case, additional monitoring of the methane content is recommended.

53777 Annual report 1975 of the Main Mining Research Institute in Katovice. Szczurowski, A. (Glowny Instytut Gornictwa, Katowice (Poland)). *Glueckauf-Forschungsh.;* **38**: No. 1, 43-46(Feb 1977). (In German).

The article contains selected research findings of the Main Mining Research Institute in Katovice which are of interest especially to foreign readers. The following issues are dealt with: Methods of coal getting and roof control; determination of the surface subsidence; mine supports; methods of blasting; fighting mining dangers underground; prevention of rock bumps; hazards of mine gas; precaution against coal dust explosions; mine ventilation; mine rescue and health protection; and liquefaction of coal.

53778 Working of thick seams of inclined position in the Warndt Mine. Dietrich, W. *Glueckauf;* **113**: No. 3, 111-114(3 Feb 1977). (In German).

Shield supports used in mine are described, and additional devices adapted to inclined seams are introduced. Conveying systems and coal-winning process are explained. Costs are compared with conventional procedure costs. 3 refs.

53779 Operations analysis of coalfaces data with coal plows and shearer loaders utilization. Matthias, P.; Oppermann, K. *Glueckauf;* **113**: No. 3, 115-119(3 Feb 1977). (In German).

Results of comparative experiments in several mines are reported. Causes for machine breakdowns are related to coal-winning methods and seam thicknesses. Repair time duration is analyzed as function of mining-organizational, electrotechnical, and machinery factors. 5 refs.

53780 Aachen coal district: review of the history of the Aachen coal mining industry. Schunder, F. *Glueckauf;* **113**: No. 3, 135-138(3 Feb 1977).

Over 800 years of production and marketing are reviewed. Organizational and labor aspects, including miners training and education, are evaluated.

53781 Organization of research work in the French coal mining industry. Pot, F. (Charbonn de Fr, Paris). *Glueckauf;* **113**: No. 4, 173-174(17 Feb 1977). (In German).

Innovations in the field of machinery and operations involving both practice and research in technical investigations centers are reported. Problem solving by specially organized teams is discussed.

53782 Cutting excavation in the Lorraine district. Assayag, M. (Houilleres du Bassin de Lorraine, Freyming-Merlebach, Fr). *Glueckauf;* **113**: No. 4, 193-200(17 Feb 1977). (In German).

Cutting methods in horizontal and inclined seams using machinery in various combinations are described. Experience with conveyors and cutter loaders is reported.

53783 High-efficiency coal faces in the La Houve Mine. Cariven, D. (Houilleres de Lorraine, Freyming-Mariebach, Fr). *Glueckauf;* **113**: No. 4, 200-212(17 Feb 1977). (In German).

Characteristics of deposits and equipment related to working methods are described. Experiments with modern machinery are evaluated and power supply requirements are listed. Production results due to modernization of equipment are reported.

53784 High-efficiency coal seams of the Provence District. Daumalin, C. (Houilleres de Provence, Fr). *Glueckauf;* **113**: No. 4, 212-223(17 Feb 1977).

In-depth analysis of basic characteristics of mining region is followed by description of mechanization, equipment for workings and conveying, and communications. Trends of short- and middle-range development plans are traced.

53785 Application of heavy duty equipment in American mines. Pearey, J.T. (Natl Coal Board, Doncaster Area, Engl). *Min. Eng. (London);* **136**: No. 190, 309-322(Mar 1977).

Various types of heavy duty equipment operating in U.S. coal mines during the early part of 1976 are reviewed. The author explains the position with reference to the expanding longwall face installations as part of efforts to increase US coal production and the involvement of the Bureau of Mines, especially with the monitoring of the new breeds of heavy duty mining equipment. The position within the British mining industry is outlined with regard to this type of equipment and serves as a background for the subsequent visits to American mines, the last of which was utilizing longwall face equipment to extract a mineral considerably harder than coal. 4 refs.

53786 Shield supports and cutting coal getting as preconditions for extraction of very thick seams. Goettig, P. (Bergwerks, Ahlen, Ger). *Glueckauf;* **113**: No. 5, 259-266(3 Mar 1977). (In German).

Extraction methods are compared in seams of varying thickness over 3m and over 4m. Operational experience is evaluated with shield supports of various types. 4 refs.

53787 Verification of long roof bolts measurement method in crosscuts overworking. Markfeld, H. *Glueckauf;* **113**: No. 5, 267-272(3 Mar 1977). (In German).

Planning of overworking and supplementary operations are discussed. Measurements procedures for three groups are described and complementary measuring methods are considered. Control shows accuracy of measuring procedure. 4 refs.

53788 Problems of productivity-linked wages in the coal mining industry. Schraeer, H. *Glueckauf;* **113**: No. 5, 288-296(3 Mar 1977). (In German).

Analysis of extent of various remuneration systems is given. Bargaining procedures and work incentives adapted to coal mining are explained, and importance of productivity-based wage system is stressed.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 53716, 53741, 53762, 53764, 53766, 53767, 53784, 53816, 53824

53789 (PB--265466) Rail transportation requirements for coal movement in 1980. Final report Apr 75-Apr 76. Desai, S.A.; Anderson, J. (Input Output Computer Services, Inc., Cambridge, Mass. (USA)). Dec 1976. Contract DOT-TSC-1000. 256p. NTIS, PC A12/MF A01.

The primary objectives of this study are to develop and present rail industry estimates of the amount of coal that will move by rail in 1980, the additional equipment and facilities required to handle the increased traffic, and the associated lead times involved. Other key report objectives are to describe present coal flows, associated operational policies and practices, and the interfaces with connecting or continuing modes of transportation. When possible 1974-1980 comparisons for these factors are made to illustrate the magnitude and direction of expected changes in levels of operations, distribution and patterns.

53790 (PB—265972) Final report and evaluation of the Ilok 4-micron coal grinding process. Soo, S.L.; Rieber, M. (Illinois Univ., Urbana (USA)). Dec 1976. Contract CO-05-60491-00. 67p. NTIS PCA04/MF A01.

This report evaluates a coal-grinding process designed by Dr. Krajeovic-Ilok. The process is evaluated according to the following criteria: (1) adequacy of the data; (2) process feasibility at 30 kWh/ton; (3) capital and operating costs; (4) process equipment characteristics; (5) direct utilization, transport and storage; (6) colloidal processing and use; (7) national benefits; (8) technology availability and construction time; (9) comparison with other processes; and (10) recommendations.

53791 Methods of improving reliability of pulverized fuel preparation systems. Dronov, Yu.D.; Luzin, P.M. *Energomashinostroenie;* No. 9, 44-45(1976). (In Russian).

It is argued that improving the pulverized fuel preparation systems is a complex problem which must be solved by research and development as well as by settlement of some organizational problems. Scientific and design effort must be concentrated at the various stages of designing this equipment. The pulverized fuel preparation systems have to be optimized according to the criterion of rated costs, taking into account the reliability factor. Introduction of an open p.f. system improves the reliability and efficiency of boiler units.

53792 Coal transportation by railroad: present and future. Hertog, J.H. pp 42-48 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

Burlington Northern railway's plans for taking care of increased coal transport are described. In 1970, Burlington Northern originated one unit train per day, by 1975 this was up to 11 per day, by 1976 to 15 per day and by 1977 to nearly 20 per day; by 1980 this is expected to reach 38 per day. Diesel locomotives assigned to unit coal trains were 39 in 1970 and 339 in 1976. Eight thousand 100 ton coal cars are involved with half being owned by customers, and the number will increase to 24,000 by 1980. Terminal loading and unloading facilities are described briefly. Dollar-wise Burlington Northern has spent $400 million on capital improvements and $1.4 billion on roadway maintenance and expects to spend another $1 billion in the next 5 years. (LTN)

53793 Coal transportation by pipeline: present and future. Jennings, W.P. pp 49-57 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

Although it is legal to transport coal by truck, barge or railway, transport by truck is impractical over the large distances in the western USA and there is no barge traffic in that arid area, so the railways are left with a monopoly which they prolong and protect by refusing permission for slurry pipelines to pass under the railroad rights of way. The few slurry pipelines which have existed have led to more efficient railway handling of coal (by unit trains) but it is estimated that pipeline transport would be less expensive (perhaps by one-half) than unit train transport. Further, railways are labor-intensive with 70 percent of their costs subject to inflation, while 70 percent of pipeline costs are related to fixed capital investment and only 30 percent (labor, electric power and supplies) is subject to inflation. Therefore, the future situation should be even more favorable for pipelines. Further, pipelines are safe, silent and without environmental problems; even the right of way can be used for other purposes. Water supply may be a problem. Pipelines, of course, require the transport of large tonnages between two fixed points for a long time; railways will still be required for a considerable amount of coal transport. (LTN)

53794 Optimization of a system of pulverized fuel preparation with gas drying of Kuznetsk coal grades. Parilov, V.A.; Ushakov, S.G. (Ivanovsk Power Eng Inst im. V.I. Lenin, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 10, 135-139(Oct 1976). (In Russian).

Different schemes of p.f. preparation with gas drying of fuel for Kuznetsk coal grades are considered. They differ by their systems of purification and methods of utilization of the spent drying agent. The effect of the scheme of p.f. preparation on the control characteristics of a boiler unit regarding the condition of ensuring reliable removal of liquid slag is demonstrated. A technico-economic evaluation of schemes and their comparison with a hot-air drying scheme is carried out. The advantages of a p.f. preparation system with an open diagram of drying with gases are shown.

53795 Equipment for removing coke from a sloping ramp. Stog, W. German(FRG) Patent 2,533,394/B/. 21 Oct 1976. 5p. (In German).

The invention concerns an equipment for removing coke from a sloping ramp by a roller attached to the lower end of the ramp to transfer the coke to a horizontal conveyor. The roller is hollow and has a circumferential opening in the longitudinal direction, which extends over the whole length of the roller but is only a slit over a small part of the circumference. The outside of the roller acts as a blocking rake, where the circumferential opening permits the removal of a certain quantity of the coke from the ramp. The circumferential speed of the hollow roller is adjusted to the feed speed of the conveyer.

53796 High speed underground locomotive manriding. Dunn, J. (Natl Coal Board, North Yorkshire Area, Engl). *Min. Eng. (London);* **136**: No. 188, 199-207(Dec 1976).

A brief review is presented of the locomotive system currently available for underground locomotive manriding, but mainly refers to the author's experiences with various diesel locomotive systems operating in the North East Area of the National Coal Board. New projects and new developments for underground locomotive systems are covered as well as associated track, roadways, manriding cars, braking and safety systems.

53797 Development of coal preparation in the United Kingdom. Pickles, G.; Stewart, A.L. (Head Wrightson and Co, Engl). *Colliery Guardian;* **225**: No. 1, 43-44, 47-48(Jan 1977).

Recent advances made in coal preparation in the United Kingdom are reviewed. The coal preparation industry in Great Britain has experienced considerable changes in recent years with varying social needs, changes in the raw feed entering washeries and changes in emphasis on product requirements. These, along with improved technology and greater attention to environmental problems, corrosion and performance, etc., have all influenced the design of washeries. Currently coal provides around 40% of the U.K.'s energy requirements and coal's share is likely to increase.

53798 Problem of optimization of pulverized fuel preparation schemes and types of crushing mills at high-capacity power units. Dobrokhotov, V.I.; Levit, G.T. (ORGRES, USSR). *Teploenergetika (Moscow);* No. 1, 4-8(Jan 1977). (In Russian).

Differences in the selection of p.f. preparation systems in the USSR and other countries are noted and analyzed. At present, p.f. preparation systems with intermediate bunkers and ball drum mills predominate in the USSR. It is found that, for the majority of solid fuels in the USSR, the most promising would be the application of direct-blowing p.f. systems. Medium-speed mills would be the most expedient for hard coal pulverization. Moist brown coal and peat could best be pulverized in p.f. systems with fan mills.

53799 Large scale screening machines for primary screening in coal preparation plants. Hampel, M. *Glueckauf;* **113**: No. 2, 80-85(20 Jan 1977). (In German with English abstract).

Characteristics of various types of machines are give and main operational phases are explained. Technical and cost comparison is followed by examples from practical experience, and a combination of various types is recommended. 1 ref.

53800 United States coal preparation practices. Deurbrouck, A.W. (Bureau of Mines, Pittsburgh). *World Coal;* **3**: No. 5, 24-26(May 1977).

United States coal preparation practices today are directed toward closed water circuits, the maximization of Btu recovery, fine-size coal washing, and three shift per day operation.

53801 Industry based research and development aids UK coal preparation plans. Jenkinson, D.E. (Mining Research and Development Establishment, Bretby, Eng.). *World Coal;* **3**: No. 5, 27-30(May 1977).

All the major functions of research, development operations and the construction of major plants are fully integrated at headquarters level under the NCB's chief coal preparation engineer.

53802 Coal preparation in the Soviet Union. Deurbrouck, A.W.; Smithson, G.R. Jr. *World Coal;* **3**: No. 5, 31-32(May 1977).

Three-product dense media separation, flotation reagent metering, heavy liquid centrifugal separation, and horizontal filtering centrifuge dewatering are examples of current USSR practice.

53803 Efficient use of modern coal cleaning plant in West Germany. Brinkmann, F. (KHD Industrieanlagen A.G., Humboldt Wedag, Bochum, Ger.). *World Coal;* 3: No. 5, 33-35(May 1977).

Larger, more efficient equipment having higher throughput capacity yet requiring less building area is helping to contain preparation costs.

53804 Australian coal processing is essential link between production and consumption. Edwards, G.E. *World Coal;* 3: No. 5, 36-37(May 1977).

Preparation of Australia's high-ash coal has developed largely as a result of increasing export trade. Coal is now a top export earner.

53805 Efficient preparation is important to South African coal. Horsfall, D.W. *World Coal;* 3: No. 5, 44-47(May 1977).

Already carried out to high standards, coal preparation in South Africa seems all set for major and exciting expansion in the future.

53806 How India handles difficult coal cleaning problems. Sarkar, G.G. (Central Fuel Research Inst., Dhanbad, India). *World Coal;* 3: No. 5, 48-49(May 1977).

India faces a number of coal preparation hurdles, including coals with difficult washing characteristics that require crushing to proper sizes prior to beneficiation.

53807 Commercial potential of supercritical gas extraction of coal. Maddocks, R.R. (Catalytic, Inc., Philadelphia); Gibson, J. *World Coal;* 3: No. 5, 53(May 1977).

In these times of rapidly changing market requirements and competition between the various energy sources, coal preparation techniques must cover the broader economics of coal production.

53808 Coal preparation economics for conversion processes. Symonds, D.F. (Birtley Engineering Corp., Salt Lake City); Norton, G. *World Coal;* 3: No. 5, 54-56(May 1977).

In these times of rapidly changing market requirements and competition between the various energy sources, coal preparation techniques must cover the broader economics of coal production.

COMBUSTION

REFER ALSO TO CITATION(S) 53605, 53617, 53631, 53653, 53666, 53678, 53699, 54223, 54224, 54704, 55065

53809 (CONF-7505139—, pp 223-234) **Effects of agglomerating characteristics of coals on combustion in pulverized fuel boilers.** Hensel, R.P. (Combustion Engineering Inc., Windsor, CT). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

Firing specifications for the degree of fineness required of pulverized fuel are based on coal rank. High rank coals must be pulverized to a finer particle size with less oversize to insure complete burnout. Combustion experience indicates that this is greatly affected by the agglomerating properties of bituminous coals above the rank of High Volatile C. This paper relates the agglomerating properties with volatile matter, heating value of both the total coal and that produced by the volatile gases, ignition temperature data, coal oxygen content, and particle surface phenomena.

53810 (CONF-7505139—, pp 235-238) **Fluidized-bed combustion of coarse agglomerating coals.** Molayem, B.; Ehrlich, S. (Pope, Evans and Robbins, Alexandria, VA). Apr 1976.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, United States of America (USA) (5 May 1975).

In Proceedings of the coal agglomeration and conversion symposium.

Coal crushed to pass through 1/2" or 1/4" screens may be fed to a fluidized-bed boiler without danger of producing massive coke agglomerates. Coals with a Giesler plasticity of 26,900 and 27,000 were fed into the furnace via a 5 foot long, 1 1/2" diameter tube immersed in the 1500°F bed. The more plastic coal did form a coke deposit on the 400°F boiler tubes located a few inches from the feeder outlet. Increasing the distance between the feeder outlet and the cool wall to 16" eliminated the problem. The reason that coke agglomerates do not form within the bed is that coal particles do become plastic when entering the hot fluidized bed. However, under stable operation, the bed is 99% free of unreacted coal, being made up of lime and ash particles. Sticky surfaces which form on the coal particles couple with bed particles which are dry. The coated coal particles are thus prevented from sticking to other coal particles. Tests have shown that a fluidized-bed boiler can be fed an agglomerating coal at the rate of 85 lb/hr, sq. ft. The bed weighs 100 to 150 lb/sq. ft. The ratio of air-to-coal is 9.0 lb/lb. Almost 10 to 15 percent of the coal does not burn in the furnace and the high-carbon content dust is collected and refired in a second fluidized bed. Sulfur oxide emissions are controlled by feeding crushed limestone with the coal at a calcium-to-sulfur mole ratio of 2.0.

53811 (FE—1511-31) **Pressurized fluidized bed combustion. Quarterly technical progress report, July—September 1976.** (National Research Development Corp., London (UK)). Oct 1976. Contract EX-76-C-01-1511. 12p. Dep. NTIS, PC A02/MF A01.

The pressurised fluidised bed combustor at the Leatherhead U.K. laboratory has been modified to operate with deeper beds and higher fluidisation velocities. Effluents will be characterised in detail under an additional analytical programme contracted through ERDA for EPA. The plant is now in the final stages of assembly. Commissioning of some sub-assemblies has taken place and Test 6 is now expected to start at the end of October.

53812 (FE—2288-12) **Direct sampling and characterization of gaseous species responsible for fireside corrosion in fossil fuel-fired systems. Third quarterly progress report, October 1—December 31, 1976.** Milne, T.A.; Beachey, J.E. (Midwest Research Inst., Kansas City, Mo. (USA)). 4 Feb 1977. Contract EX-76-C-01-2288. 23p. Dep. NTIS, PC A02/MF A01.

The direct, high-capacity, free jet, molecular beam sampling system, designed and constructed for this program, has been tested for performance and sensitivity. These tests involve both one atmosphere permanent gases and CH_4-air flames with and without the addition of fine $KHCO_3$ powder. Sampling one atmosphere argon through the 0.020 in. conical flame sampling orifice resulted in the expected amount of Ar_2 for an isentropic, shock-free expansion. Tests with air and CH_4-air flames showed complicating phenomena and troublesome interferences to be expected in coal-air flame sampling. Tests with $KHCO_3$ added to the CH_4-air flame revealed random noise spikes caused by impact of the particulate matter somewhere in the quadrupole mass spectrometer. Even with such interference, K^+ could be detected at the 10 ppM of neutral species level, indicating that we should proceed directly to a search for such species in coal-air flames.

53813 (GFERC/QTR—77/2, pp 33-37) **Fluidized-bed combustion of lignite and Western subbituminous coals.** Jun 1977.

In Quarterly technical progress report, January—March 1977.

Studies investigating coal sulfur retention on the alkaline ash of Western coals and lignites using a fluidized-bed combustor are being performed at GFERC. Studies conducted during the second quarter used a Beulah, North Dakota lignite to determine the effects of various fluidized-bed operating parameters on sulfur retention. The parameters studied were: average bed temperature, air-fuel ratio, superficial gas velocity, and to a lesser extent, average coal particle size. Preliminary results indicate that the retention of coal sulfur varied from 38 to 58 pct. Variables that significantly affect sulfur retention are average bed temperature and air-fuel ratio.

53814 (GFERC/QTR—77/2, pp 38-43) **Control of ash fouling.** Sondreal, E.A. Jun 1977.

In Quarterly technical progress report, January—March 1977.

Fouling of boiler heat transfer surfaces by ash from low-rank coals is a continuing problem resulting in significant reductions in boiler peak load capacity, efficiency, and availability. The problem has been found to be closely related to the concentration of sodium in the coals, with the ash content of coal also being a factor. No effective means has yet been found for preventing formation of fireside ash deposits in the combustion of coal with high sodium levels. Progress has been made but additional work is necessary to resolve the problem. A pilot pulverized-coal combustor of 75-lb/hr capacity, designed and constructed at GFERC, is used to measure fouling under controlled conditions. In this way, relatively small samples of candidate coals can be tested prior to plant design, and utilization criteria can be established on the basis of the characteristics of the coal to be used. Ash fouling rates and effects are also measured on-site at power plants using two methods. The first method involves operator observation and rating of the condition of the boiler on a daily basis. The second method utilizes two air cooled probes—one to determine the fouling rate and to obtain fouling ash samples, and the other to measure the furnace temperature at the test point. For all field tests, plant operating data and coal samples are collected on a daily basis. The coal samples and fouling ash samples are analyzed chemically at GFERC. Reduced data are correlated using regression analysis to determine possible unidentified causes of the fouling problem.

53815 Characteristics of reradiation in the furnace volume of a boiler. Antonovskii, V.I.; Mansurov, V.I.; Kiselev, O.V.; Oslopov,

O.I. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 9, 47-50(Sep 1976). (In Russian).

Spatial distribution of radiation fluxes in the furnaces of a PK-39 boiler fired by pulverized Ekibastuz coal is obtained. Quantitative characteristics of reradiation in the horizontal and vertical sections of the fuel spray are presented. Radiation characteristics in the layer of the furnace gas adjacent to the furnace wall are determined.

53816 Duration of combustion of p.f. particles of Vuznetskcoal of the D, G, GZH, and SS grades. Babii, V.I.; Serebryakova, A.G.; Popova, I.F.; Novitskii, N.V.; Martynova, M.I. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 1, 13-15(Jan 1977). (In Russian).

Experimental data are presented on the duration of ignition and combustion of pulverized fuel particles of Kuznetsk coal grades. Experimental coefficients are presented that are necessary for the calculation of the ignition and combustion of the p.f. of the indicated coal grades in boiler combustion chambers. They can be utilized in designing furnace arrangements.

53817 Inert coal macerals in combustion. Nandi, B.N.; Brown, T.D.; Lee, G.K. (Can Metall Fuel Res Lab, Ottawa, Ont). *Fuel;* 56: No. 2, 125-130(Apr 1977).

This paper describes one aspect of a program undertaken to establish the suitability of two unknown coals for use in large utility boilers in eastern Canada. A prerequisite of the planned experiments was to ensure that the pulverized-fired pilot-scale experimental boiler could burn the coals with a high degree of burn-out, i.e. low carbon in the fly-ash. 4 refs.

53818 Slag deposits in coal-fired boiler furnaces: some novel approaches. Austin, L.G. (Pennsylvania State Univ., University Park). *Earth Miner. Sci.;* 46: No. 8, 57, 60(May 1977).

Research programs on slag deposits in coal-fired boilers are described: tests in small boilers, electron microprobe analysis of coal particles and studies of the contact angle of slag droplets of different composition. (LTN)

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 53646, 53664, 53727, 53748, 53759, 53767, 53788, 53807

53819 (ANL/SPG—1) Survey of electric utility demand for western coal. Asbury, J.G.; Kim, H.R.; Kouvalis, A. (Argonne National Lab., Ill. (USA)). Jan 1977. Contract W-31-109-ENG-38. 73p. Dep. NTIS, PC A05/MF A01.

This report presents the results of a survey of electric utility demand for western coal. The sources of survey information are: (1) Federal Power Commission Form 423 data on utility coal purchases covering the period July 1972 through June 1976 and (2) direct survey data on utility coal-purchase intentions for power plants to be constructed by 1985. Price and quantity data for western coal consumed in existing plants have been assembled and presented to illustrate price and market-share trends in individual consuming regions over recent years. Coal source, quality, and quantity data are presented for existing and planned generating plants.

53820 (CONF-7604138—1) Financing new coal mine development in the decade ahead. Wilson, W.W. (Continental Illinois National Bank and Trust Co., Chicago (USA)). 1976. 17p. Illinois National Bank and Trust Co., Chicago, IL.

From American Mining Congress 1976 Financial Conference; Phoenix, Arizona, United States of America (USA) (9 Apr 1976).

Methods of financing coal mine development and production in the past are reviewed. If the industry is to raise the capital needed for the anticipated expansion in the next 10 years, it will probably have to generate about half of the needed amount (about $1 billion per year) by retained cash earnings in order to justify credit for the other half. Some potential problem areas are mentioned briefly: disruptive regulatory and environmental actions, labor problems, legislation (e.g., barring oil company ownership of coal mines), etc. These problems are in addition to the inherent risks involved in coal mining. (LTN)

53821 Important Spanish mining projects. de la Cuadra, L.; Prado, J. pp I.10.1-I.10.11 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

In this work, it has been shown, in the first place, how important the Spanish mining is as compared with other industrial activities. The following is a brief description of high priority fuels and metallic minerals mining whose summary is given in the enclosed statistical tables. Finally, the main mining projects which are now being developed have also been presented. These projects have been promoted in order to achieve a greater balance in our minerals and metals trade balance, keeping in mind the present problem worldwide with raw materials.

53822 Computerized systems of control and analysis of costs in the coal mining industry. Pawelczyk, E.; Mastej, R.; Miriorska, L. *Przegl. Gorn.;* 32: No. 10, 444-452(Oct 1976). (In Polish with English abstract).

A model of an integrated computerization of recording, allocation and analysis of costs in coal mines is presented. Basic solutions of the system used are discussed along with methods of accounting the records and control of cost running including the method of comparative analyses. The functional range of particular computerized systems is given stressing their functions which accomplish the control and assessment of effectiveness of production processes in coal mines and allow to attain better results by transferring the experiences of one mine to another. 6 refs.

53823 Charbonnages de France in business year 1975. Kerstan, F. *Glueckauf;* 113: No. 2, 97-100(20 Jan 1977). (In German with English abstract).

Production and exports figures are analyzed. Marketing conditions and price development are reviewed, and financial results and investment policies are considered. Wages and personnel survey is given.

53824 Canada processes coal to satisfy a demanding market. Tibbetts, T.E. (Dept. of Energy, Mines and Resources, Ottawa). *World Coal;* 3: No. 5, 21-23(May 1977).

Significant growth in Canadian coal production has boosted demand for beneficiation facilities to prepare more coal to domestic and export standards. Operators are meeting the challenge.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 53740, 53745, 53750, 53752, 53760, 53762, 53764, 53765, 53774

53825 (PB—265931) Locating miners in smoke-filled mine openings with infrared imagers. Report of investigations 1976. Stateham, R.M.; Lombardi, J.A. (Bureau of Mines, Denver, Colo. (USA). Denver Mining Research Center). Dec 1976. 22p. (BM-RI—8192). NTIS PCA02/MF A01.

Calculations based on data obtained from measurements of smoke from coal-fired powerplants predict that infrared imagers will be useful tools for smoke vision. Infrared imagers operating in the 3- to 5-micrometers spectral region have been evaluated for this purpose. A mine opening 110 meters long was filled with smoke from burning coal, and two men, wearing breathing apparatuses, moved through the smoke to serve as targets. The men were detected and identified at 80 meters.

53826 (PB—265953) Mine inspection records study. Information circular, Jan 72—Dec 74. Conroy, G.J.; Harrison, G.; Simmons, J. (Bureau of Mines, Pittsburgh, Pa. (USA). Pittsburgh Mining and Safety Research Center). Dec 1976. 17p. (BM-IC—8726). NTIS PCA02/MF A01.

The report summarizes the results of a study of mine inspections records covering 2,200 mining installations over a 3-year period ending December 1974. Tables show the relative frequency of violations of certain provisions of the Coal Mine Health and Safety Act of 1969 in particular areas of concern, such as circuit breakers, grounding, and permissibility. Examples of past use of the data and analyses are presented.

53827 Methanometric protection in methane areas. Kozlowski, B. *Przegl. Gorn.;* 32: No. 10, 434-441(Oct 1976). (In Polish with English abstract).

Principles of protection at longwall faces, roadways and near-the-shaft rooms in gassy areas are presented and commented as statutory in the Polish coal mining industry. The status being in force in the Soviet mining is also presented. 5 refs.

53828 Driving development headings in seams liable to rock bursts. Airuni, A.T.; Nikolin, W.I.; Bolszynsky, M.I. *Przegl. Gorn.;* 32: No. 11, 482-487(Nov 1976). (In Polish with English abstract).

Methods for forecasting and preventing coal, rock and gas bursts in USSR during driving development headings are described. Methods are given for controlling the effectiveness of undertakings and measures aiming at elimination or reducing the burst hazards. 10 refs.

53829 Prevention of firedamp hazard and coal dust explosions caused by rock bursts. Matuszewski, J. *Przegl. Gorn.;* 32: No. 11, 487-492(Nov 1976). (In Polish with English abstract).

Factors involving the origin of hazards are discussed; formation of firedamp explosive concentrations, dangerous zones before

the coal dust explosion and initiations of explosions. Formulae are derived which determine the increase in firedamp hazard after a rock burst. An example of firedamp and coal dust explosion caused by rock burst is given and preventioin measures are suggested. 5 refs.

53830 Water dangers. Davies, A.W.; Baird, W.K. *Min. Eng. (London);* **136**: No. 188, 175-184(Dec 1976).

This paper reviews the experience of inrushes and describes an incident where there was a flow of water from opencast coal quarries into active deep mines and where there was an inrush of water from disused workings which were being dewatered. The paper stresses the difficulty in obtaining a single answer which will cover adequately all situations in which accumulations of water may be a threat, and lists items to be considered in a more flexible approach to such situations. The incidents described revealed weaknesses in the legal framework relating to water dangers and the paper singles out amendments which have been proposed. 7 refs.

53831 Subsidence management in the North Derbyshire area. Smedley, N. (Natl Coal Board, North Derbyshire Area, Engl). *Min. Eng. (London);* **136**: No. 188, 185-193(Dec 1976).

Brief reference is made to the principles of subsidence engineering, followed by an outline history of the important legislation defining the National Coal Board's working rights relative to surface liabilities. Examples of preventive measures which may be used to mitigate the effects of ground movements are discussed, together with the way in which some of these measures hve been used in specific cases.

53832 Methodology of studying occupational accidents. Quinot, E. (Inst Natl de Rech et de Secur, Fr). *Ann. Mines;* **183**: No. 1-2, 23-34(Jan-Feb 1977). (In French).

An accident is rarely due to mere chance but, more often, is the brutal consequence of disturbances in the normal activity of a complex man-machine system in industrial enterprises. Then, he describes the three steps which must be taken to prevent accidents at work. These are: (1) Analysis of accident cases that ought to focus not only on the accident itself and those preceding it but that covers the precedents of each fact having an influence on the accident; (2) Research of similarities and singling out of 'potential factors in accidents'; (3) Use of the obtained information to prevent accidents.

53833 Hygiene and safety in mines. Koch, L. (Minist de l'Ind et de la Rech, Fr). *Ann. Mines;* **183**: No. 1-2, 35-42(Jan-Feb 1977).

The most important and urgent problems posed by the improvement in mine working conditions--those regarding the safety and hygiene of miners--are dealt with. The supervision of mines by the Service des Mines is examined along with possible interventions by the Administration which, in the case of mines and quarries, covers a much broader area than in the case of other industries. Also studied are some major problems of the extractive industry: the recession affecting coal and iron mines, specific hazards in mines, and some aspects (other than hygiene and safety) of improving the mine working conditions.

53834 Ventilation at West Cannock No. 5 Colliery. Plant, R. (North Staffs Polytech, Stoke-on-Trent, Engl). *Colliery Guardian;* **225**: No. 1, 9-13(Jan 1977).

West Cannock No. 5 Colliery is situated on the edge of Cannock Chase, Staffordshire, in the National Coal Board's Western Area. The colliery is in a geologically disturbed area and its workings are restricted in width by the cover line protecting workings on one side and the boundary with Littleton Colliery on the other. This boundary is a natural boundary consisting of a severely disturbed area of faulting. It is these limiting factors on the methods of working the colliery take which have resulted in the various systems of ventilating the colliery. This paper shows in some detail the ventilation problems which had to be faced and how they were overcome.

53835 Dependence of methane inflow on pressure relationships at the stopping. Noack, K.; Stegmanns, W. *Glueckauf;* **113**: No. 3, 121-123(3 Feb 1977). (In German).

Unusually high methane concentrations in a Ruhr coal mine are analyzed, and gas burst prevention measures are described. Results of measurements show that a modified anemometer at the stopping can indicate sudden changes in gas concentration and steam velocity. 2 refs.

53836 Controlled recirculation of ventilation--a means of dust control in face advance headings. Pickering, A.J.; Aldred, R. (Natl Coal Board, South Nottinghamshire, Engl). *Min. Eng. (London);* **136**: No. 190, 329-345(Mar 1977).

The authors discuss the requirements of auxiliary ventilation of advance heading in relation to mechanized coal faces, including a short review of the methods available. The problems of providing environmental control within the heading, particularly in relationship to the dust aspect, are fully aired. The use of various dust filtration techniques in association with the controlled recirculation of air is discussed as a means of achieving approved dust standards in the headings. A number of successful trials at both intake and return side headings in various seams and collieries are described, along with the excellent results obtained. 13 refs.

REGULATIONS

REFER ALSO TO CITATION(S) 53704, 53720

PETROLEUM

REFER ALSO TO CITATION(S) 54649, 54688, 54873

RESERVES

REFER ALSO TO CITATION(S) 54658

53837 Significance of North Sea oil for energy supplies to Western Europe and the Federal Republic of Germany. Grathwohl, M. *Meerestechnik;* **8**: No. 1, 1-8(Feb 1977). (In German).

The analysis of the structural development of primary energy consumption in the world, Western Europe and the Federal Republic of Germany indicates that oil will remain the main energy source until the end of the 20th century. A considerable improvement in the supply situation of Western Europe can be expected from the exploitation of oil reserves in the North Sea. This will lead to a rearrangement in the spectrum of the oil producing countries. In the 1980's, the United Kingdom and Norway will rank among the world's major oil producing countries. The outstanding political factor of North Sea oil lies in the considerable reduction in Western Europe's dependence on non-European countries for mineral oil supplies.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 53912, 53936

53838 (AD-A—039032) Information processing for oil and gas exploration. Volume 3. A time-domain approach to seismogram synthesis for layered media. Interim technical report. Nahi, N.E.; Mendel, J.M. (University of Southern California, Los Angeles (USA). Electronic Sciences Lab.). Jun 1976. 61p. (USCEE—490). NTIS PCA04/MF A01.

Time-domain equations, state space equations, were obtained for a model of a horizontally stratified nonabsorbtive earth with vertically traveling plane compressional waves. It develops a complete model which generates primaries and all multiples; a primaries model which generates just the primary reflection components of a seismogram; and a secondaries model which generates just the secondary reflection components of a seismogram.

53839 Experimental study of neutron fields in homogenous hydrogen bearing media. Kozhevnikov, D.A.; Mar'enko, N.N; Markhasin, M.I.; Khavkin, V.S. (Moskovskij Inst. Neftekhimicheskoj i Gazovoj Promyshlennosti (USSR)). pp no.111 p.40-56 of In Yadernofizicheskie metody izucheniya gornykh porod i nasyshchayushchikh ikh flyuidov. Vypusk 111. Moscow; Nedra (1974). (In Russian) 8 figs.; 1 table.

A series of experiments is described, in which spatial distributions of thermal and epithermal neutrons were measured in homogeneous media whose humidity was varied within a wide range. Experiments were conducted by an analogue method in sandstone and limestone. Dimensions of the model minimized the influence of marginal effects to the sonde lengths of approximately equal to 100 cm. Constancy of the volume density of the models was checked by gamma-raying. Variation in the water content of the medium was attained by adding certain amounts of snow into sand and of polyethylene into marble chips. Humidity of the resultant media was checked by laboratory methods. The results of measurements of spatial distributions obtained with the bulk media were recalculated in accordance with the analogue method for the conditions of gas-saturated strata. The factual data obtained on the models can be used for analyzing the possibility of applying neutron terhniques for estimating the porosity and gas-saturation of real strata which are oil and gas reservoirs.

53840 Results of petroleum and gas exploration in the ninth five-year period in the Kazazkh SSR and tasks for the tenth five-year period. Chakabaev, S.E.; Zhivoderov, A.B.; Kiryukhin, L.G.; Sinitsin, F.E.; Dzhumagaliev, T.N. (Mingeo, Kaz SSR). *Geol. Nefti Gaza;* No. 11, 5-11(1976). (In Russian).

In 1971-1975, oil and gas exploration was carried out in the Pre-Caspian depression, Ustyurt, Mangyshlak, Chu-Sarysuy depression, and East Aral area. Two thirds of the drilling work was concentrated in the territory of the Pre-Caspian depression and Buzachi peninsula. Regional commercial petroleum and gas prospects in subsalt (Pre-Kungur) deposits in the Pre-Caspian depression in its fringe zones has been established, a new promising oil- and gas-bearing area was discovered on the Buzachi peninsula, and commercial gas-bearing deposits have been proven in the Chu-Sarysuy depression. Altogether 17 oil and gas deposits have been discovered.

53841 Results of exploration and prospecting for oil in Kaliningrad region. Mazur, V.B.; Shakhodanov, V.A.; Al'ter, S.M.; Nikashin, E.S.; Korbukh, Yu.A. *Geol. Nefti Gaza;* No. 11, 33-36(1976). (In Russian).

The geological structure of the area (formerly East Prussia) and the state of exploration and prospecting for oil and gas is considered. Oil and gas shows are fixed in the Middle Cambrian and Devonian deposits. Commercial fields have so far been discovered only in Middle Cambrian sandstone formations. The level of the oil-bearing potential increases from east to west. The extent to which structures are filled with oil also increases correspondingly.

53842 Changing emphasis in West Germany's oil industry. *Pet. Rev.;* 30: No. 354, 329-333(Jun 1976).

Faced with sharp increases in crude oil prices, West Germany has during the past two years been concentrating on expanding its exploration and production operations, with less emphasis than until now on downstream activities. These and other changes are discussed. For example, new methods of recovery from existing fields are now being used, especially tertiary recovery methods. Also discussed are the changes that have taken place in the refining sector, import patterns and expansion plans.

53843 New surge of interest in Irish offshore sector. *Pet. Rev.;* 30: No. 355, 395-399(Jul 1976).

Ireland is dependent on imported fuel for well over three-quarters of its energy supplies. Exploration and development are therefore being encouraged off the Irish coast. Discoveries, current development and future plans are discussed. A map of drilling rights accompanies the article.

53844 New frontiers in diving technology. Davidson, L. *Pet. Rev.;* 30: No. 360, 645, 647(Dec 1976).

Development of new oilfields in the North Sea and exploration elsewhere has resulted in the performance of increasingly complex tasks at greater depths. Divers breathing a mixture of helium and oxygen work regularly at over 500 ft, while a successful dive has been carried out to 1070 feet off the coast of Labrador. New British safety regulations have mandated the use of a diving bell below 150 ft. In June, 1976, two divers went down to 977 ft and spent 15 minutes outside the diving bell on the seabed carrying out a routine task. Safety precautions also have caused the maintenance of a team of doctors in Aberdeen trained in hyperboric medicine. Although new submersibles will affect the future of individual divers, there is a role for a new type of diver--for a highly-skilled technologist, capable of handling complex technical tasks on the seabed.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 53606, 53842, 53843, 53844, 53908, 53910, 55206

53845 (BERC/TPR—77/1) Commercial scale demonstration, enhanced oil recovery by micellar-polymer flooding. M-1 project, design report. Knight, B.L. (ed.). (Marathon Oil Co., Findlay, Ohio (USA)). Apr 1977. Contract EX-76-C-01-2242. 161p. Dep. NTIS, PC A08/MF A01.

Activities in a commercial scale demonstration of enhanced oil recovery by the Maraflood process are reported. The project is situated in southeastern Illinois near the town of Robinson. This location is in Crawford County, approximately 50 miles southwest of Terre Haute, Indiana. The M-1 Project reservoir is a classic example of deposition by a meandering river with migrating point bars. Sand thickness varies from zero feet on the eastern edge of the project to about 60 feet in the center. Both multiple sand bodies stacked one above another and isolated sand lenses, found above and below the main sand, occur in the M-1 Project. Streamline and flood front modeling work have been done for the M-1 Project using a steady-state flow, unit mobility, piston-like displacement computer model. This work was used to estimate the pore volume for all patterns, including unconfined asymmetrical patterns, and to evaluate the effects of water injection at the project periphery. Data input to the streamline model included a net sand isopach and an isoporosity map, both generated during this study. One conclusion reached from the streamline modeling work was that peripheral water injection will aid project confinement and decrease the amount of process fluids required for injection into the outside row of project injectors. (JRD)

53846 (BERC/TPR—77/2) Commercial scale demonstration enhanced oil recovery by micellar-polymer flooding. M-1 project: facilities report. Knight, B.L. (ed.). (Marathon Oil Co., Findlay, Ohio (USA)). Apr 1977. Contract EX-76-C-01-2242. 112p. Dep. NTIS, PC A06/MF A01.

ERDA and Marathon Oil Company contracted together for a commercial scale demonstration of enhanced oil recovery by the Maraflood (TM) oil recovery process. This M-1 Project is located within Sections 15, 16, 21 and 22, T6N, R13W, Crawford County, Illinois, encompassing approximately 407 acres of Robinson Sand reservoir developed in the first decade of the century. The area covers portions of several waterfloods developed on 10-acre spacing in the 1950's that were approaching their economic limit. This report describes all M-1 Project facilities, how they were prepared or constructed, their purpose and how they operate: (1) wells (drilling and completion); (2) production facility; (3) injection facility; and (4) various service systems required during project development and/or operation. (48 fig, 7 tables) (DLC).

53847 (BERC/TPR—77/5) North Burbank Unit Tertiary Recovery Pilot Test second annual report, May 1976—May 1977. Trantham, J.C. (ed.). (Phillips Petroleum Co., Bartlesville, Okla. (USA)). Aug 1977. Contract EY-76-C-02-0021. 200p. Dep. NTIS, PC A09/MF A01.

During the second year of the cooperative project jointly funded by Phillips Petroleum Company and the other Working Interest Owners of the North Burbank Unit together with the United States Energy Research and Development Administration, reservoir conditioning was completed on August 2, 1976, and surfactant injection was begun. The surfactant injection phase spanned a 44-day period ending September 15, 1976, and the first phase of the graded polyacrylamide slug (2500 ppM) was begun. By the end of the reporting period five phases of the polymer had been injected and the sixth, 600 ppM, was in progress. Beginning about January 1977 tertiary oil production was confirmed and the total oil rate had reached a level of 185 BPD at a water/oil ratio of 65 at the end of the project year, May 15, 1977. A total of about 14,000 bbl. of tertiary oil had been produced. Polymer injection is expected to be complete by the end of 1977 and peak oil production is anticipated about the end of the third project year.

53848 (COO—0039-5) Interfacial effects in the recovery of residual oil by displacement: studies at Northwestern University. Annual report, March 1, 1976—February 28, 1977. Slattery, J.C.; Kovitz, A.A. (Northwestern Univ., Evanston, Ill. (USA)). Mar 1977. Contract EY-76-S-02-0039.M001. 12p. Dep. NTIS, PC A02/MF A01.

The investigation was initiated with a static analysis of the displacement of an oil segment by an aqueous surfactant solution through a capillary whose radius is a sinusoidal function of axial position (Oh and Slattery 1976). While this discussion is helpful in clarifying some aspects of the displacement problem, it can say nothing about the effects attributable to the surface viscosities. For this, the displacement is recognized as a dynamic process. The first dynamic problem was made as simple as possible while still preserving some degree of realism. An analysis of the displacement of a gas by a liquid in a straight capillary tube of uniform diameter assuming that the interface moves with a constant speed is being conducted. First results are expected within four months.

53849 (COO—0039-6) Interfacial effects in the recovery of residual oil by displacement: studies at Northwestern University. Quarterly technical progress letter, March 1, 1977—May 31, 1977. Slattery, J.C.; Kovitz, A.A. (Northwestern Univ., Evanston, Ill. (USA)). Jun 1977. Contract EY-76-S-02-0039. 6p. Dep. NTIS, PC A02/MF A01.

Objectives are to measure the effects of interfacial viscosity, the oil-water interfacial shear viscosity, and the small interfacial tension. Progress is reported, but no hard data are given. (DLC)

53850 Enhanced oil-recovery methods. Howell, W.D.; Johnson, F.S.; Johansen, R.T. (Bartlesville Energy Research Center, OK). pp 17-23 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

The recent changes in availability and the world market price for crude oil have caused the petroleum industry to reevaluate some of the newer, more complicated recovery methods. Three enhanced oil-recovery methods are described: improved fluid injection, thermal recovery, and miscible-fluid displacement. The principles of each method and the kinds of reservoirs for which they are designed to work are discussed. The first meeting is fluid-injection, in which treated fluids, mostly water, are injected into the oil-producing sands in such a manner as to force the petroleum into producing wells. Micellar fluids, surfactants, and polymers are included in this category. A second classification combines thermal-recovery methods that

introduce heat into the reservoir to reduce the viscosity of the oil. Steam, in situ combustion, and wellbore heating are included in this category. The third category is miscible-fluid displacement. Gas or liquid hydrocarbons and carbon dioxide are in this category.

53851 Problem of the effect of phenols on the setting of portland cement plugging-back mortars. Mamulov, F.G.; Tikhomirov, A.A. (Corresp Inst of Soviet Trade, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 23-28(1976). (In Russian).

The effect of phenols of different classes on the setting times and structural and mechanical properties of plugging-back mortars is investigated. It is found that phenols with paraposition of functional groups and radicals with respect to the oxy group act as retarding agents of cement setting. Hydroquinone and adurol, and the aminophenols, amidol and methol, can be proposed as grout setting retarders. Their retarding effect lasts 6 hr or more. Pyrocatechin can be used as an active accelerator of grout setting. The mechanism of these phenomena is explained.

53852 Concerning a problem of nonstationary flow of a viscoplastic liquid during sinking and lifting operations and in the presence of a permeable stratum. Guseinov, E.S.; Kuliev, T.K.; Rustamov, K.E. (Az SSR Eng-Constr Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 29-33(1976). (In Russian).

A problem related to the investigation of hydrodynamic parameters accompanying sinking and lifting operations in drilling, taking into account the presence of a permeable stratum, is considered. On the basis of a solution of differential equations of motion of a viscoplastic fluid in an annular space under appropriate boundary conditions, analytical formulas are obtained which characterize the dependence of the hydrodynamic parameters (pressure and flowrate) on the mechanical properties of the drilling fluid, the design of the borehole and the characteristics of the permeable stratum. The investigations presented permit elaboration of practical recommendations to prevent absorption of the flush fluid by strata and exuding from strata.

53853 Treatment of the Archimedes law during free sinking on a string of pipes into a borehole filled with flush fluid. Mochernyuk, D.Yu. (L'vov Polytech Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 34-38(1976). (In Russian).

Particular cases of sinking a string of drilling pipes into a borehole filled with a fluid are analyzed and possible effects obeying the law of Archimedes are shown. Attention is drawn to the erroneous views of some authors on the effect of the hydrostatic pressure or of the Archimedes ejection force on the stability of the set form of pipe string equilibrium.

53854 Experimental investigation of the process of displacement of a two-phase hydrocarbon mixture by water on a stratum model. Korotaev, Yu.P.; Gurevich, G.R.; Mamovov, I. (Moscow Inst of Petrochem and Gas Ind im. I.M. Gubkina). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 39-42(1976). (In Russian).

Results of experiments regarding the displacement of a multicomponent hydrocarbon mixture by water, using models of a 'dry' and a 'wet' stratum, are presented. The mechanism of displacement of a two-phase hydrocarbon mixture by water is revealed and characteristics of variation of the composition of the extracted gas and of the condensate content in it in the course of displacement are shown.

53855 Stratum oil production at low rates of displacement of the oil-water interface. Tikhenko, N.F. (All-Union Corresp Polytech Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 43-46(1976). (In Russian).

The problem of completeness of the displacement of oil by water in conditions of very low rates of filtration and high reservoir properties of the field is considered. Using the example of the Anastasievsko-Troitskaya field in the Krasnodar Territory, it is shown that when the rate of displacement of the oil-water interface is equal to the rate of natural absorption of water into the stratum, virtually the original relation between the capillary and hydrodynamic forces is maintained, oil is constantly in the floating state and is supported by a clear oil-water interface. At the same time, the oil production coefficient exceeds 0.9.

53856 Application of E. Schmidt's method in investigating the process of temperature distribution over the depth of the draw works brake pulley. Mirzadzhanov, D.B.; Askerov, T.M.; Agaeva, S.E. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 95-98(1976). (In Russian).

Results of calculation of thermal fluxes in the body of the rim of the brake pulley by means of E. Schmidt's method are presented. The data obtained are in complete agreement with experimental data obtained during the sinking of a drill pipe into the hole. As a result of the investigations of the distribution of temperature in the rim of the brake pulley, it is found that the removal of heat directly from its surface would be the most effective. 10 refs.

53857 Boundary effect during compression of a bar within a cylindrical cavity. Lebedev, N.F.; Sesyunin, N.A. (Perm' State Univ, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 19-22(1976). (In Russian).

The loss of longitudinal stability by a homogeneous round bar compressed by a lengthwise-constant force within a cylindrical cavity is considered. It is shown that the bar, after the first contact with the cylinder wall, has the so-called 'transitional' sector asymptotically changing over into a spiral line investigated earlier by a number of authors. The shape of the bar along its entire length, from the hinge to the spiral line, and the law of variation of bar pressure against the cylinder wall are determined. This is important for the investigation of transversal vibrations of a turbodrill in a borehole.

53858 Update on pumping unit sizing as recommended by API-RP-11L. Griffin, F.D. (Lufkin Ind Inc, Tex). *J. Can. Pet. Technol.;* **15**: No. 1, 45-51(Jan-Mar 1976).

With well over 250 case histories in the form of dynamometer cards taken all over the world in the last decade, the author finds it appropriate to review the API recommended method of sizing of pumping unit and compare it with older methods used in the past. The dynamometer cards taken covered a wide range of well conditions and included numerous combinations of gear box sizes and polished rod strokes. The gear box torque analysis and the peak and minimum polished rod loads taken from each dynamometer car are compared with these same values as computed by the API method as well as the old conventional (Mills) method. Calculations are made for the identical well conditions as shown on each dynamometer card, and deviations between measured and calculated results are plotted and analyzed.

53859 Micellar solution flooding: field test results and process improvements. Earlougher, R.C. Jr.; O'Neal, J.E.; Surkalo, H. (Marathon Oil Co, Littleton, Colo). *J. Can. Pet. Technol.;* **15**: No. 1, 52-59(Jan-Mar 1976).

This paper briefly describes the micellar flooding process, gives results of three field tests, describes a core flooding technique for process evaluation, presents a new process for direct sulphonation of crude oil and the manufacture of micel solution in the field, and summarizes process economics. The paper also comments on the future development and application of the process. 18 refs.

53860 Pattern oversweep in nine-spot waterflood pilots. Dranchuk, P.M.; Peters, E.J. (Univ of Alberta, Edmonton). *J. Can. Pet. Technol.;* **15**: No. 1, 60-63(Jan-Mar 1976).

A laboratory study was conducted on isolated and partially confined five- and nine-spot waterflood patterns. The results show that both isolated patterns continue to produce oil with continued injection, but that each pattern, when surrounded by a single ring of like patterns, behaves as if it were confined, provided the injection rate is sufficiently high to ensure a stabilized flood. 4 refs.

53861 Rock bit technology: the effect on drilling costs. Jackson, R.A. (Dresser Ind, Houston, Tex). *J. Can. Pet. Technol.;* **15**: No. 1, 64-68(Jan-Mar 1976).

The author traces the development of rock bits to 1909, the year which marks the beginning of modern-day rock bit technology, and highlights more important improvements that have been made to date. The net effect of the rock bit evolution has been increased performance and reduced drilling costs. As in the past, many future improvements are expected to be minor, with continuing evolutionary changes in design, metallurgy and manufacturing. 5 refs.

53862 Exxon readies offshore test structure. *Pet. Eng.;* **48**: No. 10, 11-12, 14(Aug 1976).

This article deals with an ocean test structure--designed to improve the understanding of wind, wave, and current forces on offshore platforms--which is to be installed in the Gulf of Mexico offshore Louisiana, this year, by Exxon Production Research Co. The structure is designed to provide a replica of conditions encountered in design level sea states at a reduced scale of one-third to one-sixth the size of full-scale conventional jacket-type platforms.

53863 New bit developments. Newsom, M.M. (Sandia Lab, Albuquerque, NM). *Pet. Eng.;* **48**: No. 11, 108, 113-115, 117(Sep 1976).

Drilling economic analyses indicate costs can be significantly reduced if the average drilling rate can be increased. Based upon these studies, drilling research at Sandia Laboratories is directed primarily at improving instantaneous penetration rate and reducing trips. Several bit design concepts now being developed at Sandia are discussed, including continuous chain drill bit and downhole changeable bit.

53864 Hydraulic fracturing: new developments. Coulter, G.R. (Halliburton Serv, Duncan, Okla). *J. Can. Pet. Technol.;* **15**: No. 4, 35-40(Oct-Dec 1976).

This paper discusses the theory of hydraulic fracturing and the new developments in fracturing fluids and fracturing techniques which are continuing to make fracturing an important production tool. The discussion of hydraulic fracturing theory includes reasons

for fracturing, objectives in fracturing and considerations in designing hydraulic fracturing treatments. The considerations in designing hydraulic fracturing treatments include formation characteristics as they control fracture extension, type of fluids used in the treatment, treatment size, proppant type and economics. 12 refs.

53865 Capillary pressure correlations for uniformly wetted porous media. Morrow, N.R. (Pet Recov Inst, Calgary, Alberta). *J. Can. Pet. Technol.;* **15**: No. 4, 49-69(Oct-Dec 1976).

The dependence of capillary pressure on wettability as defined by contact angle was investigated. Drainage and inbibition capillary pressure measurements are presented for six different types of polytetrafluoroethylene (PTFE) porous media. Changes in capillary displacement curvature are shown to be reasonably consistent from one medium to another. Conditions for observation of spontaneous imbibition behavior are used as a basis for classifying systems as wetted, intermediately-wet or non-wetted. Some aspects of the role of wettability in obtaining improved oil recovery are also discussed. 36 refs.

53866 History matching three-dimensional models using optimal control theory. Wasserman, M.L.; Emanuel, A.S. (Chevron Oil Field Res Co, La Habra, Calif). *J. Can. Pet. Technol.;* **15**: No. 4, 70-77(Oct-Dec 1976).

History matching three-dimensional reservoir simulator models by manually changing parameters is a difficult job. In this paper, the authors extend their previously published automatic history matching method to handle three-dimensional models. Special attention is given to matching historical pressures which are not single cell pressures, but instead are either wellbore pressures or volumetric averages of a vertical column of cells. Case studies are shown to illustrate productivity index estimation using wellbore pressures and to illustrate three-dimensional conductance and storage estimation using volumetric average-cell column pressures. 8 refs.

53867 Optimization techniques for weight-on-bit and rotary speed. I. Point and interval optimization. Bentsen, R.G.; Wilson, D.C. (Univ of Alberta, Edmonton). *J. Can. Pet. Technol.;* **15**: No. 4, 78-84(Oct-Dec 1976).

Currently available techniques for optimizing weight-on-bit and rotary speed are somewhat limited in scope. They determine optimum policy in the light of a part of the drilling process, rather than in the light of the entire drilling process. The object of this two-part investigation was to develop techniques which are less limited in scope, and to demonstrate the importance of optimizing the drilling process as a whole, rather than optimizing separate parts of that process. Three optimization methods were developed. It was found that each of the methods gave a worthwhile cost saving, and that the saving increased as the scope and complexity of the method increased. 14 refs.

53868 Sensitivity of production data to calculated original oil-in-place using a one-dimensional mathematical simulator. Bhatia, S.K. (Mobil Oil Can Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* **15**: No. 4, 85-90(Oct-Dec 1976).

A one-dimensional, three-phase simulator study was undertaken to investigate the sensitivity of errors in production data on the original oil-in-place calculation. The Rainbow Keg River AA Pool in Alberta was used as an example. The present work indicates that the results of a simulator study to determine the original oil-in-place are insensitive to significant random errors in the monthly oil and gas production data. The per cent cumulative error decreases with time due to the random nature of the individual errors. Therefore, costly measures to refine the production data in order to improve on the accuracy of the oil-in-place determination are not warranted. 3 refs.

53869 North Stanley polymer flood. Johnson, J.P.; Cunningham, J.W.; DuBois, B.M. (Kewanee Oil Co, Tulsa, Okla). *Pet. Eng.;* **48**: No. 13, between p 36 and 48(Nov 1976).

Recognizing the need to develop a means of replacing reserves and to salvage reserves from reservoirs nearing depletion, Kewanee Oil Co. and ERDA contracted to determine if oil can be economically recovered from a Burbank-Bartlesville sand reservoir using a polymer slug after high water oil ratios have been experienced in waterflooding. The test site is the north half of the Stanley waterflood, Stanley Stringer field, Osage County, Oklahoma. The project, because of its size and configuration, represents a field scale test of the polymer slug process. Reservoir analysis, injection testing, well preparation of initiation of polymer injection are highlighted.

53870 New look at chemical explosive fracturing. Hill, W.L.; Daggett, W.K. (Sun Prod Co, Dallas, Tex). *Pet. Eng.;* **48**: No. 13, 60, 62, 64, 66, 68(Nov 1976).

New downhole hardware and a new criterion for well selection are the basis for a fresh approach to stimulating oil and gas production by chemical explosive fracturing, which involves hydraulically fracturing a well, displacing liquid explosive into the propped fracture, and detonating the explosive. A program initiated to develop downhole equipment and to field test a new liquid explosive is described. It is concluded that a properly designed explosive fracturing treatment can give a fourfold increase in well productivity.

53871 Fire protection for the offshore industry. Hilton, J.D. (Mather and Platt). *Pet. Rev.;* **30**: No. 360, 655-656(Dec 1976).

The platforms and rigs in service with the offshore industry present almost every variety of fire hazard concentrated in a very small area. The overall strategy for protection of these complex island structures, located anything up to 500 kilometers from shore, is based on extensive use of sea water. In addition, installations incorporating halon gas and carbon dioxide as extinguishing agents are used in specific application in such areas as generator turbine, switchgear and battery rooms. Automatic detection and sprinkler systems are among the devices discussed.

53872 FEA regulations/enhanced oil recovery: comments of Interstate Oil Compact Commission. Oklahoma City, OK; Interstate Oil Compact Commission (1977). 7p.

Within the United States, there remains 300 billion barrels of oil which apparently cannot be recovered by known conventional technology. It is generally believed that much of this oil can be produced eventually, given the proper economic climate which will stimulate the necessary technological development. The Interstate Oil Compact Commission urges the Federal Energy Administration to reconsider its regulations with a view to promoting and encouraging technological experimentation. This can only be done by providing fewer obstacles to technology development and greater price incentive leeway.

53873 Political doubts fog offshore forecast. McNally, R. *Pet. Eng.;* **49**: No. 1, 21-24(Jan 1977).

Worldwide offshore drilling activity is reviewed. Rigs are in good supply and are well deployed. The United States' legislative picture is uncertain and nationalization problems linger in Indonesia, India and Venezuela. It is concluded that there are indications that many of the countries that have already traveled the same nationalization road some members of the United States' government are looking at are having second thoughts. Offshore activity will tend to center around areas with known favorable political atmospheres, and that means countries anxious to develop newly found reserves and countries in which nationalization has has about run its course. Such areas include Spain, Greece, and Egypt.

53874 Field expectations and the determinants of wildcat drilling. Attanasi, E.D.; Drew, L.J. (Geological Survey, Washington, DC). *South. Econ. J.;* **44**: No. 1, 53-67(Jul 1977).

The purpose of this paper is to examine several alternative behavioral hypotheses relating to the determinants of field level exploration activity. In particular, this paper examines the intertemporal relationship between operator behavior, changes in profit expectations and the perceived field-size distribution. Alternative formulations and the duration of operator expectations are examined. The plan of the paper is as follows: First, the nature of field exploration activity is briefly described along with a formulation of field expectations. Following this, a discussion of the method of analysis and the data are provided. Empirical results and tests of alternative expectations mechanisms are then presented. The conducting section of the paper discusses the significance of the results for future reserve estimation and supply modeling efforts. 24 refs.

53875 Method for stimulating the recovery of crude oil. Goins, J.T. US Patent 4,033,411. 5 Jul 1977. Filed date 2 Jan 1976. 8p.

There are disclosed several embodiments of a method for stimulating the recovery of crude oil from a formation penetrated by a well bore. In each embodiment, a mixture of the vapors of a solvent for the crude oil and gas which is a product of combustion is injected into the formation.

53876 Methods for fracturing well formations. Holtmyer, M.D.; Githens, C.J.; Tinsley, J.M. (to Halliburton Co.). US Patent 4,033,415. 5 Jul 1977. Filed date 14 Oct 1976. 16p.

The present invention relates to a crosslinked aqueous gel for fracturing and placing propping agents within subterranean formations, said gel having a viscosity in said formations greater than about 20,000 centipoises and having pumping characteristics in turbulent flow approaching those of water.

PROCESSING

REFER ALSO TO CITATION(S) 53894

53877 Classification of combined petroleum processing plants. Doroqochinskii, A.Z. (Groznyi Pet Inst im. M.D. Millionshchikov,

USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 52-54(1976). (In Russian).

Principles of classification of combined petroleum processing plants are proposed. In accordance with these principles, examples of classification of four modern combined plants are presented.

53878 High-temperature adsorption of C_7-C_{13} n-paraffins on MGNA A zeolite. Ryazantsev, Yu.P.; Kurnoskina, V.V. (Grozyni Pet Sci-Res Inst, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* 12: No. 5-6, 346-349(1976).

In the reported experiments, the equilibrium adsorption of C_7-C_{13} n-paraffins has been investigated at 400°C. For C_8 and higher hydrocarbons, the Langmuir equation gives a good description of the experimental data over a range of pressure p from 17-50 mm to 760 mm Hg. The adsorption isotherms for n-tridecane and for mixed C_{10}-C_{16} n-paraffins present in a 190-260°C cut are essentially the same under the conditions investigated. The empirical constants obtained in this work can be used in process design calculations for the recovery of n-paraffins from petroleum cuts by means of type A zeolites. 19 refs.

53879 Upper limit of urea adduct formation with binary mixtures of straight-chain alkane and 1-alkene with same number of carbon atoms per molecule. Matishev, V.A.; Krupina, A.A. (Gubkin Moscow Inst of the Petrochem and Gas Ind, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* 12: No. 5-6, 359-361(1976).

A study has been made of binary mixtures consisting of a straight-chain alkane and a straight-chain 1-alkene with the same number of carbon atoms per molecule (from 8 to 18 inclusive). It has been established that the ULA (upper limit of adduct) for urea adducts with the primary component of these mixtures (straight-chain alkane) varies linearly with the mass concentration of the second component (straight-chain alkene) and can be described by the equation THETA(bin=THETA-C*Δt. For each pair of hydrocarbons investigated, constant gradients Δt have been determined over a range of mass concentrations of the second component from 0 to 99%. Nomograms have been constructed for the graphical determination of gradients Δt for mixtures with n=7-9 and n=10-18. 3 refs.

53880 Distribution of adduct-formation inhibitors between phases in spent water/urea slurry. Smolina, T.A.; Chegodaev, F.A.; Klimenok, B.V. (Ufa Pet Inst, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* 12: No. 5-6, 362-365(1976).

Results of experimental investigations are presented which show that the bulk of the inhibitor material in spent water/urea slurry is present in the dissolved state; only a very small part is adsorbed on the urea crystals. The optical density of the urea solution is related to the concentration of inhibitors in the solution. The inhibitors of adduct formation are thermally stable and do not distill over with the water. 3 refs.

53881 Optimal design of rotational equipment for close fractionation of hydrocarbons. Koren, R.V. (Stavropol' Polytech Inst, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* 12: No. 5-6, 379-383(1976).

In the close fractionation of mixtures of hydrocarbons with similar boiling points, in which 30 or more theoretical stages of change in concentration may be required, an attractive approach is the use of rotational apparatus (RA) with a set of concentric rotating and fixed disks overlapping each other. The operating scheme of such apparatus gives repetitive spraying and deformation of the liquid drops within the limits of the contacting device (CD), in which the rates of mass transfer between liquid and gas or vapor may be tens or even hundreds of times the rates achieved in film mass transfer. In the design of RA with concentric rings, many elements are subject to design development in the interest of optimality; however, the main questions are the number of rings in the CD, the height and diameter of the rings, and the rational speed of ring rotation. Designing scheme recommended for designing RA with concentric ring for close fractionation is included. 15 refs.

53882 Method of determination of chromium content in organic chromium compounds. Borisova, V.I.; Lyashenko, A.F.; Rozhkov, I.V.; Nazarova, K.G.; Trofimova, I.A. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* 12: No. 5-6, 397-399(1976).

The simplest and most economical method for combating the electrical charging of petroleum products is the use of special antistatic additives. Such additives may contain trivalent chromium salts of synthetic fatty acids. This paper describes a new analytical method for the determination of chromium in antistatic additives, which is based on the decomposition of chromium salt complex by boiling the additive with hydrochloric acid. Analytical procedure is described in some detail and results obtained with a number of commercial samples of antistatic additives are tabulated. This method is applicable to the analysis of organic chromium compounds containing not less than 0.1% chromium. 5 refs.

53883 Pretreatment of crude oil before refining. Levchenko, D.N. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* 12: No. 5-6, 411-415(1976).

The basic aim in pretreating crude oil before refining is the production of high-quality petroleum products from this crude oil. Crude oil pretreatment is a large factor in obtaining higher levels of economic efficiency in petroleum refining processes and in petrochemical production. When well-pretreated crude oil is being processed, the operating runs of atmospheric and atmospheric-vacuum pipestill units for crude oil distillation may be two or three times as long; other effects that may be observed are significant increases in the quantity of the petroleum products, particularly residual stocks, and increases in the operating life of catalysts in secondary refining processes. It has been established that, for certain types of crude oil, the removal of water-soluble salts does not eliminate hydrogen chloride corrosion in the distillation process. Such crudes probably contain water-insoluble organic chlorine compounds (or, more precisely, organic halogen compounds) that are decomposed upon heating the oil to evolve hydrogen chloride. It has been demonstrated experimentally that, when crude oils with high contents of nitrogen compounds are distilled, considerable amounts of hydrogen chloride are evolved. This suggests that the source of hydrogen chloride evolution is the thermal decomposition of organic chlorine complexes of the type of $Ni(C_5H_5N)\ 4Cl_2$,$Ni(C_5H_5N)_2[(NH_2)_2CS]Cl_2$, etc. Results of desalting of crude oil in several Russina refineries are tabulated. 30 refs.

53884 Properties of Pd/zeolite catalyst for hydrogenation of aromatic hydrocarbons in the presence of sulfur. Agafonov, A.V.; Kruglikov, V.Ya.; Landau, M.V.; Radchenko, E.D.; Goncharova, N.V.; Konoval'chikov, O.D.; Poezd, D.F.; Svirina, V.P.; Maikova, M.V. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* 12: No. 5-6, 420-423(1976).

The dearomatization of petroleum stocks is of great importance in the production of high-quality jet fuels and certain special solvents. The most economical method for removing aromatic hydrocarbons in these cases is hydrogenative dearomatization. This process requires a catalyst with high hydrogenating activity and stability against poisoning by sulfur compounds present in the petroleum feedstock. This paper presents results of an investigation which was carried out in order to find the optimal composition for the zeolite component of the palladium-zeolite catalysts. The feedstock for hydrogenation was o-xylene containing 0.5% sulfur in the form of thiophene. For long-term tests with a feedstock, the authors selected a Pd/zeolite/Al_2O_3 catalyst containing 65% zeolitic component and 35% binder. The long-term tests on this zeolitic catalyst consisted of the hydrogenation of a 142-230°C straight-run cut containing 16% aromatic hydrocarbons and 0.21% sulfur. The results of these tests are tabulated. The catalyst selected has been shown to provide an adequate degree of dearomatization of the petroleum feedstock, along with hydrotreating; the catalyst is resistant to the poisoning effect of sulfur. The degree of conversion and the distillation curve of the product can be regulated by adjusting the process conditions. 9 refs.

53885 Fuel cuts from gas condensates of Central Asian fields. Alieva, R.B.; Seregin, E.P.; Akhundova, F.B.; Skovorodin, G.B.; Mirbagirova, E.A. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* 12: No. 5-6, 431-433(1976).

This paper presents data from a study of stabilized condensates from the Achak, Naip, and Gugurtli fields (Central Asia), with the aim of producing jet fuels from these materials. The stabilized gas condensates from these fields are sulfur-free, distill over a wide range, and consist mainly of light oils. The characteristics of 130-230°C cuts from these condensates indicate that they meet the principal quality requirements from T-7 jet fuel. Main characteristics of these fractions are tabulated and evaluated. It is shown that the 130-230°C cut taken from mixed Naip and Achak condensates can be regarded as a component of RT fuel. Whereas the proposed flow plan for the production of RT jet fuel includes a unit for primary distillation and hydrotreating, fuel can be produced from the gas condensates by primary distillation alone and used directly as RT jet fuel.

53886 Calculation of phase equilibrium constants and enthalpies of petroleum cuts. Zhvanetskii, I.B.; Platonov, V.M. (Sci-Res Inst of Synth Alcohols and Org Prod, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* 12: No. 5-6, 433-436(1976).

In the use of mathematical simulation to investigate and design crude-oil distillation processes, the accuracy of the results depends to a considerable degree on the reliability of information available on such properties as the phase equilibrium constants and the enthalpies of petroleum cuts. In most cases, phase equilibrium constants of petroleum cuts are found from nomograms by a laborious graphic/analytical method. When the calculations are computerized, these nomograms are usually put into the form of tables; this requires a great deal of preliminary work and will lead to an unjustifiable increase in the amount of the computer memory banks occupied by the input information. It is more rational in this situation

to use calculational relationships. This paper presents a calculation method for the phase equilibrium constants of a petroleum cut K$sub p$. Relevant equations derived are given and results for ethane and heptane are tabulated. As demonstrated by this investigation, the calculational relationships proposed make it possible to compute the enthalpies of petroleum products with an accuracy far better than that of previously known formulas; here the average absolute deviations amount to 1.17 and 2.16 kcal/kg for petroleum cuts in the liquid and vapor states, respectively. 17 refs.

53887 Combination flow plan for processing distillate raffinates from mixed West Ukrainian crudes to produce lube oils and waxes. Pereverzev, A.N.; Roshchin, Yu.N.; Vozhnova, G.P.; Sokolova, S.P. (Groznyi Pet Sci-Res Inst, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 5-6, 436-440(1976).

Medium-wax crudes from the fields of the Western Ukraine are valuable raw materials for the production of high-quality waxes and lube oils. The authors are developed the process technology for simultaneous production of these materials from raffinates derived from mixed West Ukrainian crudes (79% Dolina and 21% Borislav). In this paper they present results from the development of the combination flow plan for processing distillate raffinates obtained by furfural extraction of 320-440° and 440-500°C cuts. The most important properties of these raffinates are listed in table 1. The results from these studies are presented in Table 2. The data demonstrate the desirability of using batchwise dilution of feed with solvent in processing the 320-440°C raffinate and single dilution in processing the 440-500°C raffinate. In slack-wax deoiling, solvents with considerably higher contents of MEK can be used in comparison with the solvents used in dewaxing. In many cases, straight MEK can be used in a slack-wax deoiling. The authors present the recommended process indices for combination dewaxing of raffinates from 320-440° and 440-500°C cuts and deoiling of slack wax; also shown are the most important properties of the end products. 9 refs.

53888 Hydrodynamics of reaction coils in delayed coking units. Valyavin, G.G.; Fryazinov, V.V.; Ezhov, B.M.; Sedov, P.S.; Alekseev, P.M.; Vetoshkin, N.I.; Khairudinov, I.R. (Bashk Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 5-6, 460-463(1976).

One of the basic types of equipment that determines the technoeconomic indices of delayed coking units is the furnace. Because of rapid coking of the reaction coils, furnaces in delayed coking units have relatively short runs between shutdowns for maintenance. The rate of coke deposition in the tubes depends on the quality of the feedstock, the hydrodynamic conditions in the coil, the residence time of the feed mixture in the furnace tubes, the heat flux density through the tubes, etc. This paper presents results of an experimental study in which effect of mass variables on the course of delayed coking was investigated. Design details of furnace coil, which was used in experiments, are given. It is pointed out that, in order to ensure long runs of delayed coking units between shutdowns for maintenance, particular attention must be given in the furnace design to establishing optimal hydrodynamic conditions that will eliminate the presence of the disperse form of flow. This can be achieved through preparation of a feedstock of specific distillation characteristics, through the use of coils with variable diameter for the tube bank, and through charging optimal amounts of feedstock and turbulizer to the coil. 7 refs.

53889 Catalytic desulfurization of naphtha over Indian bauxite. Chakraborty, P.; Kar, A.K. (Indian Inst of Technol, Kharagpur). *Indian J. Technol.;* **14**: No. 7, 340-344(Jul 1976).

The vapor phase desulfurization of naphtha was carried out in a fixed bed in the presence of Indian bauxite samples of different origins under different operating conditions in respect of catalyst volume, temperature and space velocity. At a liquid hourly space velocity of 0.5, wutg 25 cc bauxite of Lohardaga origin and at an average bed temperature of 425°C, the maximum desulfurization efficiency of 82% was achieved. Among the sulphur compounds present in naphtha, thiophenic type was found to be most resistant to decomposition. The main decomposition product was found to be H$sub 2$S. 10 refs.

53890 Development of demand and adaptation techniques in refining. Beaufils, J.P. (Inst Fr du Pet). *Rev. Energ.;* **28**: No. 290, 15-21(Jan 1977). (In French).

Following the oil crisis of 1973, most industrialized countries have taken steps to reduce their energy dependence with regard to petroleum products. The structure of demand in the refineries will be considerably modified in the coming years. To face up to these changes, refining will therefore have to adapt its production tools. The article considers the techniques available today for such an adaptation.

53891 Coaversions of hydrocarbons. Owen, H. (to Mobil Oil Corp.). US Patent 4,032,432. 28 Jun 1977. Filed date 28 Aug 1975. 8p.

A combination operation is described comprising gas oil cracking in the presence of a large and smaller pore size crystalline zeolite dual component cracking catalyst in which combination C_6 minus products are separated and catalytically upgraded under selected conditions providing cyclization and/or carbon chain growth as by oligmerization and polymerization. Conversion of C_6 and lower boiling hydrocarbons is particularly accomplished with the smaller pore crystalline zeolite of the dual component catalyst.

53892 Hydrorefining asphaltenic petroleum charge stocks. Petri, L.W.; Conway, J.E. (to UOP Inc.). US Patent 4,032,433. 28 Jun 1977. Filed date 30 Apr 1976. 8p.

Petroleum stocks containing asphaltenes, sulfur and nitrogen can be hydrorefined with an extruded refractory inorganic oxide catalyst support. The support is prepared by admixing a peptizing agent, a surfactant and a water-insoluble particulate organic polymer having a particle size of from about 1 to about 200 microns with a powdered refractory inorganic oxide and extruding the resulting mixture.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 53878, 53882, 53884, 53885, 53886, 53887, 53889, 53890, 53928

53893 Lube oil dewaxing in dichloroethane/benzene solution. Skobel'tsyn, Yu.A.; Basin, B.Yu.; Bolotov, L.T.; Pavlov, L.V. (A. Sheripov Groznyi Pet Refinery, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 5-6, 356-358(1976).

This paper presents results of an experimental investigation, in which effect of process variables on dewaxing of lube fractions of petroleum distillates by means of dichloethane-benzene mixture was studied. Experimental data are tabulated which were obtained with a solvent/feedstock ratio from 4/1 to 5/1, separation temperature from -23 to -25°C, preheat temperature of +56°C, and mixture cooling rate of 150-180°C. It is demonstrated from these data that the processing of raffinates obtained from mixed crudes with added cylinder distillate is inefficient, owing to the higher temperature gradients and the lower oil yields. The highest yields of dewaxed oil are obtained when the raffinates used as charge stock are obtained from Zhirnovsk and Anastas'evka long resids. 4 refs.

53894 Production of coke with spherulitic structure from carboid-free feedstock. Klokova, T.P.; Zaitseva, T.M.; Smidovich, E.V.; Zhibitskaya, F.B. (Gubkin Moscow Inst of the Pet and Gas Ind, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 5-6, 365-367(1976).

Currently, petroleum coke in grades KNPE and KNPS is produced by pyrolysis of kerosine-gas oil cuts and subsequent coking of the hydraulic tar. Either grade KNPE or grade KNPS may be obtained, depending on the severity of the pyrolysis conditions. It is well known that the decisive role in the formation of coke of the KNPS type is that of carboids, a high concentration of which in the pyrolysis tar will favor the formation of the spherulitic structure of grade KNPS coke. In this paper the authors present results from a feasibility study for the production of coke with a spherulitic structure from a highly aromatic feedstock that is essentially carboid-free, this feedstock being derived from a source other than pyrolysis tar. The use of such types of feedstocks should facilitate the transition from the low-efficiency method of shellstill coking to the more modern semicontinuous chamber coking process. The starting material used as a feedstock in this study was a low-sulfur cracked tar produced at the Drogobych Petroleum Refinery. It is demonstrated that, from three types of feedstock that are similar in composition and do not contain carboids, but represent different numbers of stages of destructive conversion, it is possible to obtain cokes of different structures even though the coking regimes are identical. 6 refs.

53895 Determination of contaminant particle size in fuels and oils. Bol'shakov, G.F.; Timofeev, V.F.; Sibarova, I.I.; Gashko, V.A. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 5-6, 464-467(1976).

Results of an experimental study are presented in which the contaminant particle size distribution of fuels and lubricating oils was determined from the optical information obtained from light scattering at 20 to 180$degree$ using the statistical regularization method. The authors have developed experimental installations for obtaining information on the microstructure of fuels for particle size from 0.1 to 20 μm. They also demonstrated the possibility of obtaining information on the kinetics of the formation, coagulation, and accumulation of solid-phase particles in fuels not under the influence of any discernible factors. 7 refs.

53896 Hydrodesulfurization of petroleum cokes at elevated hydrogen pressures. Akhmetov, M.M.; Syunyaev, Z.I.; Zaitseva, S.A.;

Kirillov, T.S. (Ufa Pet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 47-51(1976). (In Russian).

The process of hydrodesulfurization of petroleum cokes at elevated (up to 52 kg/cm^2) hydrogen pressures is investigated. The relations of dependence of the extent of desulfurization of cokes of different origin on particle size and regime parameters--pressure, temperature, duration of treatment, volumetric rate of hydrogen feeding, rate of heating--are obtained. The possibility of using the process of hydrodesulfurization to obtain special coke types with residual sulfur content of 0.1--0.2% is shown.

53897 Investigation of elastic and viscous properties of mineral oils MG-30 and VMG-3. Golik, A.Z.; Rudenko, A.P.; Cholpan, P.F. (Kiev State Univ im. T.G. Shevchenko, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 58-61(1976). (In Russian).

Results of an investigation of the shear, viscosity, ultrasound absorption coefficient, ultrasound propagation velocity, and density of the MG-30 and VMG-3 mineral oils at the saturation line from -30 to +90$degree$C are presented. The adiabatic compressibility and the second coefficient of viscosity are also calculated and discussed.

53898 Concerning solution of the heat conductivity equation with an internal heat source in a semielliptical system of coordinates. Mekhrabov, A.O. (Az SSR Eng-Constr Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 62-67(1976). (In Russian).

Results of a solution of the heat conductivity equation for ellipse-shaped plates and a semi-elliptical plate, as well as for half-plane with a clot in the shape of a half-line, are presented regarding the case of variable thermophysical coefficients in a semielliptical system of coordinates with an internal heat source. The temperature field for n-alkane vapors is determined taking into account the temperature dependence of thermophysical coefficients. The calculations were carried out on a Minsk-32 computer.

53899 Composition of isoalkanes and cycloalkanes present as impurities in treated liquid paraffins. Cherednichenko, V.P.; Garbalinskii, V.A.; Petrov, A.A. (All-Union Sci-Res Inst of Protein Synth, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 5-6, 340-345(1976).

A study has been made of isoalkane and cycloalkane impurities in two commercial samples of treated liquid paraffins. About 40 hydrocarbons of branched and cyclic structure have been identified by gas chromatography. The major part of the impurities in the liquid paraffins (80-90%) consists of isoalkanes, among which 2-Methylalkanes and 3-methylalkanes predominate. Also present in significant amounts are alkylcycloalkanes and isoprenoid hydrocarbons. The composition of the isoalkane and cycloalkane impurities in liquid paraffins indicates that most of these materials (with the exception of the isoprenoid hydrocarbons) find their way into the paraffin through adduct formation with urea, not through sorption on the surface of the adduct or urea crystals. 10 refs.

53900 Influence of individual organic sulfur compounds on the radiation resistance of hydrocarbons present in lubricating oils. Potanina, V.A.; Gorbach, V.A.; Zherdeva, L.G.; Zaslavskii, Yu.S.; Ponomareva, T.P. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 5-6, 368-370(1976).

When lubricating oils or similar individual hydrocarbons are exposed to ionizing radiation, a protective effect is given by the addition of certain individual sulfur-containing compounds such as monosulfides, disulfides, mercaptobenzothiazoles, phenyl butyl dithiocarbonates, etc. In this paper the authors present results from a study aimed at testing the protective action of three individual organic sulfides on hydrocarbons recovered from mineral oils; these sulfides were phenyl decyl sulfide (PDS), phenyl cyclohexyl sulfide (PCS), and diphenyl sulfide (DPS). The sulfides were added to the hydrocarbons in amounts equivalent to 0.25-0.5% sulfur by weight. The samples were irradiated with ^{60}Co γ quanta, in contact with air, at a temperature of 40-45°C and with a dose absorption rate of about 900 rads/sec. Radiation resistance is defined as the ability of a lubricant to maintain its principal physicochemical properties unchanged under the action of ionizing radiation. In most studies the criterion for rating radiation resistance has been the change in viscosity at 50°C., Extensive experimental data are tabulated and evaluated. It is demonstrated that individual organic sulfides are effective additives for increasing the radiation resistance of hydrocarbons. 5 refs.

53901 Lowering the solid point of residual fuels by use of copolymer of ethylene and vinyl acetate as additive. Nikolaeva, V.G.; Kyuregyan, S.K.; Englin, B.A.; Mitusova, T.N.; Levina, E.G.; Terteryan, R.A.; Ponomarev, M.S. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 5-6, 423-425(1976).

The use of certain types of residual fuels may produce considerable difficulty due to their poor low-temperature properties. This disadvantage is particularly evident when using residual fuels produced from medium- and high-wax crudes. One of the possible means for improving the low-temperature properties of residual (boiler) fuels is the use of pour-point depressant additives. This paper presents results from a study of the efficiency of the copolymer of ethylene with vinyl acetate when added to fuels of various compositions. Samples of F-5 residual marine fuel oil and Grade 40 residual fuel oil were tested. The physicochemical properties of the test fuels are tabulated. The effectiveness of the pour-depressant additives is reduced slightly when the fuels are stored for prolonged periods. However, all of the additive-blended fuels (with the exception of those produced from high-wax crudes) meet the solid-point requirement of the appropriate standard. The fuels without additive, under these storage conditions, become unacceptable with respect to solid point.

53902 Composition of aromatic hydrocarbons in medium-viscosity lubricating oil from ust'-balyk crude. Kucheryavaya, N.N.; Zherdeva, L.G.; Siryuk, A.G.; Sidlyaronok, F.G.; Brodskii, E.S.; Rozanova, Z.I. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 5-6, 426-431(1976).

In many properties such as viscosity-temperature characteristics, thermal-oxidative stability, and susceptibility to additives, lubricating oils produced from Siberian crudes differ significantly from those produced from crudes of the Volga-Ural basin. These differences are due to differences in chemical group composition and to the structural features of the various classes of hydrocarbons and sulfur compounds present in the oils. The most improtant components of lube oils are aromatic hydrocarbons, the content of which amounts to 20-25% in oils produced by selective treating. This paper presents results from an investigation of the aromatic hydrocarbons recovered from an oil produced by phenol treatment of a medium-viscosity lube distillate from Ust'-Balyk crude. The aromatic hydrocarbons were freed of the saturated hydrocarbons by successive chromatography, and then characterized by IR spectroscopy. The characteristic feature of the aromatic hydrocarbons recovered from the oil is shown to be that the average molecule consists to the extent of 75-86% of a saturated part, i.e., paraffinic chains and naphthenic rings. Among the saturated structures in the molecule, paraffinic chains predominate. Such an overall structure gives positive values of the viscosity index for the aromatic hydrocarbons. 10 refs.

53903 Multifunctional type of action of pour-point depressant additives for diesel fuels. Gureev, A.A.; Lebedev, S.R.; Gerasimova, G.N. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 5-6, 441-443(1976).

In this paper results of an experimental program are presented which show that high-molecular-weight, surface-active pour-depressant additives for diesel fuels (copolymer of ethylene with vinyl acetate, unsaturated ester/naphthalene) are multifunctional additives. While giving a considerable improvement in low-temperature characteristics of diesel fuels, these additives also improve the fuels' protective properties and give a slight improvement in thermal stability. 7 refs.

53904 Comparison of three colour scales used for determining the colour of pale petroleum products. *Pet. Rev.;* **30**: No. 356, 488-489(Aug 1976).

Results of a collaborative study of three methods for determining pale petroleum products color--IP17, ASTM D156 and WOMA--are presented. It is shown that the differences between the results obtained in the collaborative test program and those reported earlier are quite small, but are sufficient to illustrate the difficulty of comparing colors determined using different scales. 4 refs.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 53844, 53871

53905 Content of cancerogenic substances in flue gases when burning gas and fuel oil. Tsirul'nikov, L.M.; Konyukhov, V.G.; Dimant, I.N.; Vladimirov, E.N. (Asia Sci Res Gas Inst, USSR). *Teploenergetika (Moscow);* No. 9, 32-35(Sep 1976). (In Russian).

In order to determine the possibility of reducing the discharge of benz(a)pyrene (BP) into the atmosphere, industrial tests were carried out on gas and fuel oil-fired boilers. Samples were taken by the aspiration method with subsequent filtration of the combustion products. A special cooler was used to cool combustion products to 20--30°C to prevent deterioration of the polymer-based fabric. Soot and BP are formed as a result of the same pyrogenetic process; therefore, it is possible to appraise the amount of BP by the pressure of soot. It is found that changeover to gaseous fuel permits reduction of BP content to a small percentage.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 53890, 54694, 54695, 54696

53906 (TID—27648) **Availability of liquid fuels from conventional sources for electric utility gas turbines, 1975—1985. Final report.** Lichtblau, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1977. Contract W-7405-ENG-48. vp. Dep. NTIS, PC A05/MF A01.

This study projects the availability and price range of these fuels for the generation of electric power by means of simple or combined-cycle gas turbines in the U.S. The first section of this report attempts to determine the likely total volume of liquid turbine fuel required by utilities in 1980 and 1985 under different assumptions. A frame of reference for the general availability of the required volume is established by projecting world crude oil supplies and likely prices over the next ten years as well as U.S. demand for crude oil and refined products and the domestic and foreign supply sources required to meet this demand in 1980 and 1985. An analysis is made of the outlook for the following turbine fuels: LPG, naphtha, distillate fuel oil, and residual fuel oil. (DLC)

53907 **British oil: how much is it really worth.** Callow, C. (Rowe Rudd and Co, London, Engl). *Pet. Rev.;* **30**: No. 355, 389-394(Jul 1976).

Various evaluations of North Sea oil are reviewed as well as several recent financing plans. Optimistic forecasts are numerous. However, the author concludes that prospects of these forecasts being met for the total benefit of British oil depends to a considerable measure on how the financing of these fields actually turns out, in spite of the favorable risk/reward ratio.

53908 **Petroleum and natural gas.** Lugg, W.G. (Can Dep of Energy, Mines and Resour). *Can. Min. J.;* **98**: No. 2, 160-168(Feb 1977).

The outlook for the Canadian oil and gas industry is a mixed one. There has been a marked slowdown in locating and developing new supplies of availabile oil and gas. Nevertheless the potential for finding large reserves in the frontier areas, particularly gas, still exists although locating these reserves has not proceeded at the pace previously predicted. Nor has development of the Athabasca tarsands proceeded at the pace necessary if it is to have a major impact on the predicted domestic oil supply shortages of the 1980s. However, escalating prices for crude oil will likely rekindle industry interest in tars and development during the next decade. Exploration in the frontier areas has been encouraging.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 53931

53909 **Effluent treatment process.** Oldham, G.F. (to British Petroleum Co., Ltd.). US Patent 4,032,439. 28 Jun 1977. Priority date 3 Jan 1974, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

A method for treating effluent water containing suspended oil from a gravity separator, comprises passing the effluent through a sand filter so as to remove suspended oil and produce water suitable for effective passage through a biological percolating filter; periodically stopping the flow of effluent water through the sand filter before suspended oil can pass; and backwashing the sand filter with water to remove suspended oil therefrom.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 55082, 55083, 55188

53910 **Environmental research program for drilling in the Canadian Beaufort Sea.** Hnatiuk, J. (Gulf Oil Can Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* **15**: No. 1, 29-36(Jan-Mar 1976).

A multi-million-dollar environmental research program consisting of 33 wildlife, biological, oceanographic, meteorological, sea ice and oil clean-up studies related to the southern Beaufort Sea is described. The studies are designed to provide ecological baselines, a better understanding of the physical environment, knowledge related to the consequences of a possible oil spill and means of oil clean-up in ice-infested waters. Seasonal offshore drilling in the Canadian Beaufort Sea from a floating vessel has been approved in principle and is scheduled to be undertaken during the open-water period of 1976. The results of the studies discussed will be used to set operating constraints to safeguard the environment and minimize any adverse impact. 4 refs.

53911 **Probabilistic model for dispersive oil losses beneath oil booms.** Fallah, M.H. (Mathematica Inc., Princeton, NJ); Stark, R.M. *Ocean Eng.;* **3**: No. 6, 383-390(Dec 1976).

Oil booms are deployed to contain the spread and drift of spilled oil on waterways. Wave action and current turbulence can cause substantial oil losses from the boom. Oil particles that are vertically dispersed, when carried by current, escape beyond the oil boom perimeter. This process, called "dispersive oil loss," is studied using a random walk model. Probabilistic descriptions for the volume of oil loss are derived. A hypothetical oil slick is used to illustrate application of the model.

53912 **Mining technology for offshore hydrocarbon development.** Snyder, H.L.; Winsor, W. (Mem Univ of Newfoundl, St. Johns). *CIM Bull.;* **70**: No. 778, 62-69(Feb 1977).

Should oil and gas be proven in commercal quantities on the Labrador Shelf, current technology is not adequate for production operations in this severe environment, which includes yearly invasion of pack ice and icebergs. The fishery of this section of the North Atlantic is a vital resource to which a major oil spill or blow-out would impose an intolerable burden. This means that production systems must be designed and built to be fail-safe. The experiences of mining in Bell Island and Cape Breton have shown that it is possible to operate beneath the ocean floor, and this technology may hold the key for safe, reliable and economic production. This paper attempts to define particular problems and outline possible solutions. 18 refs.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 53908, 53910, 54689, 54692, 54693

53913 (NP—22138) **1976 legal report of oil and gas conservation activities.** (Interstate Oil Compact Commission, Oklahoma City, Okla. (USA)). 1977. 34p. Oil Compact Commission, Oklahoma City, OK.

This report summarizes legal activities in 29 states and the Canadian provinces of Alberta, British Columbia, and Ontario. Legislature, administrative, and judicial activities are reported. (DLC)

TRANSPORT, PIPELINES, AND HANDLING

53914 **Effect of high molecular petroleum components on the thickness and rheological properties of a boundary layer.** Markhasin, I.L.; Strokina, V.R.; Bogadnov, V.S.; Kondrashov, O.F. (Ufa Pet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 68-71(1976). (In Russian).

It is shown that the composition of the petroleum boundary layer is nonuniform across its thickness. As the solid surface is approached, the content of heavy oils, resins and asphalthenes increases. The content of asphalthenes and their molecular weight exerts a determining influence on the thickness of the petroleum boundary layer. During the formation of the boundary layer, fractionation of the asphalthenes in accordance with their molecular weights takes place. Asphalthenes with the minimal molecular weight exhibit the highest surface activity. Petroleum boundary layers have special structural and mechanical properties.

53915 **Determination of optimal parameters with simultaneous route selection for main oil pipelines.** Volokhov, V.Ya. (Ufa Pet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 79-83(1976). (In Russian).

The problem of joint selection of the optimal route and of parameters of a trunk oil pipeline for an isothermal process of transshipment at a steady rate of operation is formulated and solved. The search for an optimal variant is carried out in a three-dimensional net, consisting of hydraulic slope lines, by means of a program realizing an algorithm developed on the basis of the method of successive analysis of variants. As a result of the solution, a route with minimum reduced costs is found, account being taken of the optimum values of the diameter, number of strings, working pressure in the oil pipeline, as well as of the optimum location of pumping stations and layout of pipes with different wall thickness depending on the head pressure distribution on it.

53916 **Rational operation of pumping engine equipment and of the storage capacities of the head pumping station.** Novoselov, V.F.; Veremeenko, A.A. (Ufa Pet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 84-86(1976). (In Russian).

Construction of the mathematical model of operation of a head pumping station is illustrated on an example.

53917 **Spot loader trials promise simplified product shipment by rail.** Cranfield, J. *Pet. Rev.;* **30**: No. 351, 153-156(Mar 1976).

A new rail tanker loading system, now under trial at Phillips-Imperial Petroleum's refinery on Teeside, is described. Known as the

Fast Filler, the system eliminates the need for all the complicated pipework and carriage used in other mechanized systems. Instead it uses the principle of the multicolor ball-point pen: the all-rubber flexible probes are lowered vertically from the same housing. Other operating improvements incorporated into the design of the Fast Filler are highlighted, and a cost comparison is made with some other mechanized loading systems.

53918 Case for the bottom-tow method for laying offshore pipelines. *Pet. Rev.;* **30**: No. 359, 593, 595, 597-598(Nov 1976).

The greater expense of using conventional pipe laying techniques in deeper and rougher northern North Sea waters in terms of hardware, men and time delays has promoted interest in bottom towing. The basic components in the bottom-tow system are a shore make-up area and a towing vessel. The make-up area can vary, but might be between 1,000 and 5,000 ft. Sleepers are installed for making up pipes and for storage of pipe-strings. A launchway is prepared with roller or track dolly units, and there is also space for material and cable storage, pontoon and rigging areas, and so on. The towing was done by an 8,000hp supply and anchor-handling tug. Inspection of a 2,000 ft pipeline towed over a 240 mile route out and back over the Norwegian trench showed the effectiveness of the approach. A commercial installation has been completed involving the connection of three 2,600 ft sections of 32in diameter pipeline to the booster platform providing recompression of gas from Frigg field en route to Peterhead, Scotland. The strings, which form part of a twin pipeline system, were placed in 310 ft of water. The costs of installation by towing are said to be 30% to 70% less than those for a traditional lay-barge, depending on commitment times for lay-barges and other specific factors. On top of this saving there is a saving through ploughing in, because a trenching barge is not needed, and an additional saving due to the elimination of damage repair facility down-time costs.

53919 Prospects for the future of the tanker market. Carpenter, A.; Drewry, H.P. *Pet. Rev.;* **30**: No. 359, 603-604(Nov 1976).

The severity of the tanker slump, and the fact that it will persist for some time into the future, have led many of those involved in the industry to consider ways in which the tanker surplus can be reduced, and ultimately eliminated in order to improve the state of the tanker market. The most direct action is the cancellation of new building orders. Owners started to pursue this course of action around the middle of 1974 and since that time almost 60 million dwt has been cancelled. Given the probability of a maximum 8% annual growth in oil demand, a balance in the tanker market can only be achieved by the introduction of one or more of the measures currently being contemplated by INTER-TANKO and IMIF, such as accelerated scrapping (possibly in the form of a scrap and build policy) or a coordinated lay-up scheme, or the universal acceptance of segregated ballast. The most probable area for new construction is in the up to 70,000 dwt class where surpluses could well disappear before 1980. Freight rates for such small ships would then rise at a faster rate than for medium and VLCC's.

53920 Tanker markings and hazardous loads. *Pet. Rev.;* **30**: No. 359, 607, 609(Nov 1976).

Extremely stringent regulations govern both the construction and use of road tanker vehicles used for the movement of petroleum and petroleum products. A major move forward in dealing with the problems of hazardous load movements occurred in 1973 when Britain's Chemical Industries Association issued a comprehensive code of practice on the movement of hazardous loads. Apart from rules concerning driver instruction, detailed precautions are outlined in the code for the safe loading and unloading of cargoes, carriage and use of fire extinguishers, carriage and use of gas masks where toxic or irritant gases are likely to be emitted as a result of an accident and details of action necessary in the event of an accident. The code was taken a step further in 1975 when a voluntary scheme (Hazchem) of safety sign for road tankers carrying dangerous substances was launched on a national scale. Now, the Transport Hazard Information System (THIS) will make tanker marking mandatory. The new controls will pay particular attention to written instructions to drivers on emergency and first-aid procedures, the safe parking of vehicles and the construction and maintenance of the containers and their fittings.

53921 Detecting leaks in pipelines and storage tanks. Butts, E.O. *Eng. J. (Montreal);* **60**: No. 3, 45-47(1977).

Leaks in pipelines and storage tanks are just as serious as oil spills at sea, since they result in pollution of ground water and other problems. Some causes of such leaks are listed. The lack of stringency in Canadian and other codes is pointed out. Available detection methods are described. Incentives to improve the situation are needed. (DLC)

PROPERTIES

REFER ALSO TO CITATION(S) 53882, 53884, 53885, 53897, 53898, 53899, 53900, 53901, 53903, 53914, 54880, 54926

53922 (AD-A—038977) **Development of high stability fuel. Final report 1 Jan—30 Nov 76.** Taylor, W.F.; Frankenfeld, J.W. (Exxon Research and Engineering Co., Linden, N.J. (USA). Government Research Lab.). Dec 1976. Contract N00140-74-C-0618. 88p. (EXXON/GRU—17.GAHF.76). NTIS PCA05/MF A01.

An extended program has been completed which meets the original objective of developing a High Stability JP-5 fuel. This fuel exhibits the markedly improved thermal stability characteristics required for high speed aircraft and yet retains the general physical characteristics of present day JP-5. This development makes possible the design of an improved performance Mach 4-5 speed range aircraft without resorting to cryogenic or specialty fuels and simplifies logistic problems because of its ability to be used in lower speed aircraft. Phase III of this contract was devoted to a study of the effects of selected jet fuel additives and of certain dissolved metals on the thermal stability of deoxygenated JP-5. In addition, a room temperature interaction between a pyrrole and a carboxylic acid, previously found to be deleterious to storage stability, was studied in more detail. The results of fuel stability research over the length of the contract are summarized in this report and the implications of these results for establishing new fuel specifications are discussed. The potential effects of various refinery processes on fuel stability are reviewed. Recommendations concerning storage and handling techniques are also summarized.

53923 (BERC/RI—77/7) **Analyzing heavy ends of crude: Bartlett oil.** Sturm, G.P. Jr.; Woodward, P.W.; Vogh, J.W.; Holmes, S.A.; Dooley, J.E. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). May 1977. 26p. Dep. NTIS, PC A03/MF A01.

A heavy crude oil produced from the Bartlett field in southeastern Kansas by the Solfrac process developed by ERDA was characterized by procedures developed, in large part, by the ERDA Energy Research Centers in Bartlesville, Okla., and Laramie, Wyo., through the American Petroleum Institute Research Project 60. After removal of the solvent used in the Solfrac process, two distillate fractions accounting for about 50 percent of the solvent-free crude were prepared and analyzed by a combination of techniques including acid and base extractions, adsorption chromatography, gel permeation chromatography (GPC), mass spectrometry (MS), nuclear magnetic resonance (NMR) spectrometry, and gas chromatography. Concentrations of major hydrocarbon and sulfur compound types were well within the ranges observed for five previously studied crude oils, but acid and base fractions were smaller for the Bartlett crude. High-resolution mass spectral data for the Bartlett crude showed the presence of some oxygenate material which were not determined in the previous studies of petroleum crudes. These data plus physical and chemical properties determined by the ERDA/BERC routine crude oil analyses provided an extensive characterization of the portion of Bartlett crude boiling below 540°C. These data are valuable for determining appropriate refining processes for efficiently upgrading this crude to more useful products.

53924 (BERC/RI—77/8) **Atomic absorption techniques for determining vanadium and nickel in crude oil.** Grizzle, P.L.; Wilson, C.A.; Ferrero, E.P.; Coleman, H.J. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). May 1977. 19p. Dep. NTIS, PC A02/MF A01.

Four different techniques for sample preparation were evaluated for determining vanadium and nickel in crude oils by atomic absorption (AA) spectroscopy: (1) The flame-analyzed dilution method which consists of direct-flame AA analysis after diluting the sample with a suitable organic solvent; (2) the flame-analyzed, wet-ashing method in which the sample is combusted and the residue is then dissolved before flame analysis; (3) the flameless, dilution method which involves flameless AA analysis of the sample following dilution with a suitable organic solvent; and (4) the direct, flameless method in which the crude oil or residue is directly analyzed by flameless AA. The flame-analyzed dilution method yielded erratic and inaccurate analytical results for samples of crude oils as well as for a residual sample containing standard amounts of vanadium and nickel; hence, it is unsatisfactory for oil-identification. Similarly, the direct, flameless method is unsatisfactory owing to the small concentration range available for analysis (less than approximately 15 ppM). Both the flame-analyzed, wet-ashing and flameless-dilution methods yield reliable and reproducible (better than 10%) quantitative data for nickel and vanadium in crude oils and crude oil residues. Results demonstrate that the error associated with the loss of volatile metal containing compounds upon wet-ashing is within the reproducibility of the technique. Although wet-ashing may be slightly more reproducible, the flameless-dilution method is much

simpler and faster and is recommended as the better of the two procedures for routine determinations of trace metals for oil identification.

53925 Hydrocarbon group composition of TS-1 and RT (jet) fuels from West Siberian crudes. Khokhlacheva, M.V.; Kogan, L.O.; Polyakova, A.A.; Radchenko, E.D.; Rozhkov, I.V.; Khaikin, M.D. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* 12: No. 5-6, 415-417(1976).

In the reported investigation, mass spectrometric methods have been used in studying the composition of jet fuels obtained from various crudes. These crudes were distilled in an apparatus with a column separating capability equivalent to 20-22 theoretical plates. TS-1 fuels were obtained; the characteristics are listed in a table. It is shown that the straight-run TS-1 fuels from West Siberian crudes typically have low contents of total and mercaptan sulfur, but are inadequate in thermal stability. Another table presents the results from determinations of the hydrocarbon group composition of TS-1 type fuels obtained from West Siberian and Romashkino crudes. The paraffinic hydrocarbons predominate in these fuels. The TS-1 fuels obtained from crudes of the Surgut dome differ from the fuels from the Nizhnevartovsk dome in having higher contents of paraffin hydrocarbons and lower contents of naphthenic hydrocarbons; in this respect, the fuels from the Surgut group of crudes are quite similar to those from Romashkino crude. Recommendations for practical uses are given. 9 refs.

53926 Low-temperature thermal quantities for five alkyl-substituted pentanes. Finke, H.L.; Messerly, J.F.; Douslin, D.R. (Bartlesville Energy Research Center, OK). *J. Chem. Thermodyn.;* 8: 965-983(1976).

Low-temperature calorimetric quantities were determined for 2,3-dimethylpentane, 3,3-dimethylpentane, 2,2,3,3-tetramethylpentane, 2,2,4,4-tetramethylpentane, and 3,3-diethylpentane from 10 to about 400 K. Molar heat capacity at saturation pressure of the condensed phases, transition and melting temperatures, and enthalpies of transition and fusion were measured by adiabatic calorimetry. From the results, the thermodynamic quantities [H/sub s/(T) - H°(0)], S/sub s/, and C/sub s/ were derived and tabulated over the experimental temperature ranges of the crystalline and liquid states of each substance, and except for 2,3-dimethylpentane the standard entropies in the perfect gas state at 298.15 K were determined with the aid of literature data for vapor pressure and enthalpy of vaporization. Because, 2,3-dimethylpentane could not be crystallized, its thermodynamic properties are reported only for the glass and liquid states.

STORAGE

REFER ALSO TO CITATION(S) 53921

53927 Gas-freeing aviation fuel storage tanks. Fardell, P.J.; Houghton, B.W. (Build Res Establ, Fire Res Stn, Engl). *Pet. Rev.;* 30: No. 354, 349-352(Jun 1976).

Before any maintenance can be started in large aviation fuel tanks, all traces of fuel must be removed. A new gas-freeing technique is described along with equipment, apparatus and procedures used. The new technique involves the use of natural and mechanical ventilation, together with an air-driven pump for removal of liquid residues from the irregular bottom of the tank. Advantages of this technique are briefly discussed.

53928 Link in the chain. Surridge, D.J. (Unitank Storage Co). *Pet. Rev.;* 30: No. 356, 457-463(Aug 1976).

The objective of this article is to try to identify the future role of public storage companies as a vital link in the logistics of worldwide movements of bulk liquid products. The four market sectors cited are distribution storage, seasonal surpluses and refining imbalances, trader activities, and storage for industrial concerns. Future requirements in technology are briefly reviewed.

COMBUSTION

REFER ALSO TO CITATION(S) 53905

53929 (N—77—17184) The combustion of liquid fuel in tunnel burners. Goldman, Y.; Lipahitz, A.; Manheimer-timnat, Y. (Technion-Israel Inst. of Tech., Haifa. Dept. of Aeronautical Engineering). Oct 1976. 51p. (TAE—293). NTIS, PC A04/MF A01.

Subm-Sponsored by the Natl. Council for Research and Development, Israel and the Kfa Juelich, West Germany.

After discussing the general characteristics of tunnel burner combustion, the droplet vaporization process is studied numerically and it is shown that recirculation is very important. The influence of four different tunnels on the performance of burners in a model industrial furnace is investigated experimentally. The best combustion quality is achieved by the tunnel, which produces the most favorable recirculation pattern, as corroborated by water model experiments.

53930 Efficiency of combustion of high-sulfur-content fuel oil within a wide range of loads in the furnace of a TGMP-314 boiler. Mysak, I.S.; Kruk, M.T. (ORGRES, South Branch, USSR). *Teploenergetika (Moscow);* No. 1, 15-19(Jan 1977). (In Russian).

Material is presented on the efficiency of combustion of the M-100 fuel oil in a TGMP-314 boiler furnace. It is found that good control of the furnace process is exercized in the load range (0.3-1.0)D/sub nom/ when the boiler is equipped with mechanical steam-operated atomizers 'Titan' with the average initial nonuniformity of distribution of fuel among atomizers Ngreater than or equal to0.02.

53931 Corrosion aggressiveness of flue gases of supercritical pressure boilers burning sulfurous oil fuel. Magadeev, V.Sh. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 1, 19-23(Jan 1977). (In Russian).

Results of investigations carried out on serial supercritical pressure boilers TGMP-114 and TGMP-314 designed for oil fuel and natural gas firing are presented. The content of sulfur in oil fuel was 2.3-2.6%, ash content was 0.08-0.1%. It is shown that minimal corrosion of the metallic packing of the regenerative air heater is achieved when sulfurous oil fuel is burned with low air excess in combination with effective regular cleaning and air preheating in calorifiers.

53932 Oil burner test stand experiments with heavy oil having a high asphalt content. Pischke, J. (Borsig G.m.b.H., Berlin (Germany, F.R.)). *Energie;* 29: No. 2, 32-35(Feb 1977). (In German).

Combustion of a heating oil with 8% asphalt content presents no more problems than the combustion of an oil with 3% asphalt if the conditions of combustion are the same. The preheating temperature required to achieve the necessary spray viscosity is the same for both oils. However, there is some increase in solid particle content of the smoke and grain size. Moreover, the experiments have shown that a firing cannot be judged by the smoke spot number alone, without taking into account the solid particle content of the smoke. The CO content of the exhaust gases never exceeded the average of 0.01% during the whole experiment.

NATURAL GAS

REFER ALSO TO CITATION(S) 54649

RESERVES

REFER ALSO TO CITATION(S) 54658

53933 Non-conventional resources of oil and natural gas. Grenon, M. *Rev. Energ.;* 28: No. 290, 22-29(Jan 1977). (In French).

Important points from a conference on conventional and non-conventional petroleum and natural gas resources, organized by IIASA and UNITAR at Luxenburg, Austria, in July 1976 are recalled. Additional petroleum resources in small deposits, offshore deposits, obtainable by enhanced recovery, heavy oils, oil sands, and oil shale are reviewed and some data about their reserves are given.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 53839, 53840, 53842, 53843

53934 (MERC/CR—77/6) Petrography of selected Devonian shale core samples from the CGTC No. 20403 and CGSC No. 11940 wells, Lincoln and Jackson Counties, West Virginia. Larese, R.E.; Heald, M.T. (West Virginia Univ., Morgantown (USA). Dept. of Geology and Geography; West Virginia Geological and Economic Survey, Morgantown (USA)). 1976. Contract EY-76-C-05-5199. 33p. Dep. NTIS, PC A03/MF A01.

Forty selected core samples of "Devonian shales" from two wells in western and southwestern West Virginia were analyzed petrographically. Lithologically these samples may be grouped into 6 rock types: shale, silty shale, dolomitic shale, shaly silstone, shaly dolostone, and dolostone. Mineralogically, illite comprises the major part of theargillaceous fraction, whereas quartz constitutes the principal nonclay mineral. Carbonate is present in most specimens and is generally dolomitic. The most prevalent heavy mineral is pyrite. Dark gray (N3) to brownish-black (5YR2/1) organic, rich shale constitutes the most distinctive rock type in the principal "Brown

shale pay zone interval. Organic matter occurs in several forms and comprises as much as 4.4% of the shale. Vertical mineral-lined fractures are important in facilitating gas accumulation and migration in most pay zones. Dolomite is the main mineral constituent in these linings; however, small amounts of calcite and barite are also present. Mineral linings serve as propping agents to hold fractures open and thus are important in maintaining porosity and permeability along the fractures. Lenses of silt-size quartz and feldspar may serve as conduits for movement of gas into these fractures. (16 figures)

53935 Formation of the Orenburg gas condensate deposit. Maksimov, S.P.; Larskaya, E.S.; Khakhanova, I.N. (All-Union Sci Res Geol Inst, USSR). *Geol. Nefti Gaza;* No. 11, 11-22(1976). (In Russian).

Specific features of distribution of microinclusions and compositions of epibitumens (residual 'oil saturation') in a section of the Carbonaceous-Lower Permian productive rock mass of the Orenburg deposit are considered. Variations of the composition of oil and gas across the section and over the area of the deposit are analyzed. On this basis, it is concluded that there exist several relatively well isolated primary oil paleobeds, that the deposit has been filled with gas much later, and that the formation of gas condensate took place partly owing to the dissolution of some light components of the primary oil.

53936 Morphogenetic types of tectonic formations of Chechen-Ingushetia. Sterlenko, Yu.A.; Sterlenko, E.V.; Salamov, R.A. (Groznyi Pet Inst im. M.D. Millionshchikov, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 13-17(1976). (In Russian).

Problems of development of detailed morphogenetic classifications of tectonic structures in Chechen-Ingush ASSR with a view to correct, and justified evaluation of its oil and gas potential resources are considered. Morphological types of local tectonic rises are singled out.

53937 Iterative method of solving nonlinear problems of filtration of a liquid and a gas. Klement'ev, A.F.; Klement'ev, S.F. (Bashk State Univ im. 40 Oct, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 55-57(1976). (In Russian).

The problem of unsteady state rectinlinear-parallel filtration of a gas in a restricted closed stratum, with a constant pressure being maintained in the gallery, is considered. An approximative iterative method of solving the nonlinear differential equation describing this process is presented.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 53842, 53843, 53868, 53873, 53874, 53876, 53908

53938 New gas plants commissioned in Bass Strait development. *Gas World Gas J.;* **181**: No. 4696, 622, 624-626(Nov 1976).

Process details are given for a new $20 million (Australian) gas processing train recently completed in Gippsland, just southeast of Melbourne, Australia. The train, consisting of two column shaped fractionating units, completes the third stage of a construction program bringing the plant's daily capacity to 54,000 tonnes of propane and butane and 12,500 tonnes of ethane. The units separate the ethane, propane and butane mixture sent by underground pipeline in liquid form from the Longford gas processing and crude stabilization plant, some 198 km away. The new train will add another 12,000 tonnes of propane and butane and 3500 tonnes of ethane to the plant's daily production capacity.

53939 Monoethanolamine process for sulfur removal from circulating oil used in sour gas wells. Kauffman, D. (to Shell Oil Co.). US Patent 4,033,410. 5 Jul 1977. Filed date 20 Feb 1976. 6p.

Circulating oil used for removal of sulfur in sour gas wells is contacted with an aqueous solution of an organic amine and allowed to separate into an oil phase and an aqueous amine phase containing the sulfur. The oil is then returned to circulation to the gas well and the aqueous amine phase is removed for regeneration which is accomplished by precipitating the sulfur with CO_2 and stripping out the CO_2 from the aqueous amine solution with heat and/or vacuum.

PRODUCTS AND BY-PRODUCTS

53940 Plant and process for vaporizing and heating liquid natural gas. Mandrin, C. (to Sulzer Brothers Ltd.). US Patent 4,033,135. 5 Jul 1977. Priority date 7 Feb 1975, Switzerland. 8p.

The plant obtains heat energy from a diesel engine plant in order to vaporize a flow of liquid natural gas. The obtained heat is conducted via a circuit containing a hydrocarbon heating agent to the liquid natural gas pipeline. In one embodiment, heat energy is also obtained from a further heat source such as sea water to heat the liquid natural gas. In another embodiment, a part of the heat energy obtained from the diesel engine plant is used directly to heat the liquid natural gas.

53941 Single mixed refrigerant, closed loop process for liquefying natural gas. Swenson, L.K. (to J. F. Pritchard and Co.). US Patent 4,033,735. 5 Jul 1977. Filed date 8 Nov 1976. 16p.

A fluid material is cooled through a temperature range exceeding 200°F by heat exchange with a single mixed refrigerant composition in a heat exchange zone forming a part of a closed loop refrigeration cycle thus assuring high reliability and low investment by virtue of simplification of the equipment required and ease of control thereof. The process is especially useful for liquefaction of natural gas. Refrigerant in the refrigeration loop containing constituents having increasingly lower boiling points is successively directed from a compression zone to a condensation zone, thence to a heat exchange zone, next expanded in an expansion zone, returned to the heat exchange zone for countercurrent flow against the refrigerant flowing therethrough from the condensation zone to the expansion zone, and finally returned to the compression zone. The natural gas is directed to the heat exchange zone and liquefied therein by countercurrent flow against the cold refrigerant stream flowing from the expansion zone to the compression zone. The refrigerant is made up of C_1 to C_5 hydrocarbons plus nitrogen as an optional constituent with the relative proportions of the constituents being controlled so that the combined cooling curve of the hot refrigerant stream and the feed gas closely matches the heating curve of the cold refrigerant stream in a sense that the curves are in close proximity at the lowest temperature levels thereof and relatively uniformly and slowly diverge as the highest temperature points on the curves are approached.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 53905

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 53906, 53907, 53908

53942 Natural gas: a geographical perspective. Osleeb, J.P.; Sheskin, I.M. (Ohio State Univ., Columbus). *Geogr. Rev.;* **67**: 71-85(1975).

This paper shows the utility of a linear programming model for predicting natural gas (NG) flows between producers and local distributors. This model is used to replicate past flow patterns and then to derive NG flows from estimates of 1980-1990 supply and demand in USA and Canada. Flows in 1990 are estimated, assuming that the federal government allocates the NG to satisfy equal proportions of the demand in each state. The analysis indicates areas where NG deficits are likely and identifies possible locations for SNG and for LNG facilities and new pipeline routes. 33 footnotes, 7 figures, 2 tables. (DLC)

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 55081

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 53870, 53872

53943 (UCRL—50036-77-1) **LLL gas stimulation program. Quarterly progress report, January—March 1977.** Hanson, M.E.; Shaffer, R.J.; Anderson, G.D.; Heard, H.C.; Montan, D.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 May 1977. Contract W-7405-ENG-48. 27p. Dep. NTIS, PC A03/MF A01.

The elastic/porous-flow model for simulating the hydraulic fracturing process was further developed. The elastic parts of the model were used to analyze surface deformations and some aspects of the stress/strain field resulting from a hydraulic fracture. Various iteration schemes were explored for solving the elastic parts of the problem more quickly. The incomplete Cholesley-conjugate gradient method proved considerably faster than a point iteration scheme, although it requires more computer memory. The model in its present state includes coupling between the stress field and the pore pressure (as described by the Terzaghi equations). Crack permeability is defined as a function of aperture. Another ongoing project is a study of the medium-stress mechanical properties of Devonian shale cores from West Virginia. The Rio Blanco nuclear gas-stimulation

experiments are being analyzed with a view to interpreting important reservoir parameters. Laboratory hydraulic fracturing experiments were also begun. 20 figures

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 53913, 54693, 54697, 54698

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 53949, 54699

53944 Approximative relation for hydraulic calculation of low-pressure gas pipelines. Olenev, V.A. (Perm' Polytech Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 18, 46(1976). (In Russian).

A simple monomial exponential formula of hydraulic resistance of low-pressure gas pipelines is proposed. It may be used to solve a number of gas distribution system optimization problems, problems of analysis of their operation, and problems of computer modeling. This formula fairly exactly approximates the normative design relation the use of which for the solving of the indicated problems is made difficult by the presence of an exponential binomial. A comparative analysis shows that the proposed relation describes considerably more precisely the regularities of gas pressure losses in conditions of a subquadratic resistance region, characteristic for low pressure gas distribution systems, than the ordinarily employed formula valid only in the region of hydraulically smooth pipes.

53945 First self-propelled concrete LNG carrier. *Gas World Gas J.;* **181**: No. 4696, 618-620(Nov 1976).

The vessel represents an entirely new concept for the transportation of LNG, using a reinforced concrete hull self-propelled carrier with insulated cargo tanks integrated within the hull. The vessel--with an overall length of 290 m and a beam of 44 m--is in the size range of the largest steel LNG carriers currently being built. It is of monolithic, concrete construction throughout the entire hull. The inner surface of the hull is separated from the cargo by insulation incorporating primary and secondary barriers. In the event of an explosion the very composition of the concrete makes it resistant to major structural failure.

53946 UK transmission system construction failures appraised. Knight, R.C.A. (Br Gas Corp Eng Res Stn, Newcastle-upon-Tyne, Engl). *Gas World Gas J.;* **181**: No. 4696, 631-632, 634(Nov 1976).

An analysis is made of fine grain structure, fracture behavior, welding by the stovepipe method, low pressure air test, seamless pipe failures, alloy segregation and field fabrication problems. 15 refs.

COMBUSTION

REFER ALSO TO CITATION(S) 53905

53947 Environmental and energy aspects of burning mixtures of natural gas and hydrogen fuel. Varde, K.S. (Univ. of Michigan, Dearborn). pp 422-427 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

The possibility of burning natural gas-hydrogen mixtures has been investigated and the following conclusions are reported: 1. Energy content per unit volume of NG-H mixture is lower and this will have to be taken into account in the combustion and distribution systems. 2. The effect of increasing hydrogen content is to increase the upper flammability limit and the rate of heat release in the combustion zone; however, the effect on the flame temperature is not very pronounced. 3. As hydrogen content is increased CO levels drop but the emission of hydrogen is expected to increase. Due to the wide flammability region of hydrogen, this factor will have to be dealt with carefully in rich burning systems. 4. Overall, NG-H mixtures seem quite practical particularly at low hydrogen content.

STORAGE

53948 Qualitative evaluation of the efficacy of surface-active agents when operating underground gas reservoirs. Maksimov, V.M.; Filinov, M.V. (Moscow Inst of Petrochem and Gas Ind im. I.M. Gubkin, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 72-78(1976). (In Russian).

A method of calculation of the process of displacement of water by gas with the aid of surface-active agents is considered. Unlike the existing descriptions of this process, the method in question takes more fully into account the main characteristic differences and the physical mechanism of displacement and has a broader area of application. Results of the calculations presented permit making a rough quantitative evaluation of the efficacy of utilization of surface-active agents when creating and maintaining an underground gas reservoir, and evaluation of the radius of the gas region and of the gas volumes that can be pumped into the stratum on condition that the maximum completeness of displacement is realized.

53949 Underground storage of gas: making up for nature's maldistribution. Sherman, C.W. (Pennsylvania State Univ., University Park). *Earth Miner. Sci.;* **46**: No. 8, 57-60(May 1977).

The value of underground natural gas storage facilities in the northeastern USA for natural gas that can be transported in the summer is described. The various problems in the development of such facilities (both technical and legal problems) are discussed. (LTN)

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 54690

53950 (NTIS/PS—77/0384) **Oil shale mining, processing, uses, and environmental impacts. Volume 1. 1964—1975 (citations from the NTIS Data Base). Report for 1964—1975.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 200p. NTIS PCN01/MF N01.

See also NTIS/PS—77/0386 and NTIS/PS—77/0387.

Government-funded research on exploration, mining, retorting, chemistry, environmental impacts, and policies relating to oil shale research is covered. Abstracts discuss such things as oil shale air and water pollution control, production of synthetic fuels, use of spent oil shale in road construction, identification of research and development priorities, and in situ recovery of shale oil. (This updated bibliography contains 195 abstracts, none of which are new entries to the previous edition.)

53951 (NTIS/PS—77/0385) **Oil shale mining, processing, uses, and environmental impacts. Volume 2. 1976-April, 1977 (citations from the NTIS Data Base). Report for 1976—Apr 77.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 153p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0319, NTIS/PS—75/362 and COM—74-10969. See also NTIS/PS—77/0386 and NTIS/PS—77/0387.

Government-funded research on exploration, mining, retorting, chemistry, environmental impacts, and policies relating to oil shale research is covered. Abstracts discuss such things as oil shale air and water pollution control, production of synthetic fuels, use of spent oil shale in road construction, identification of research and development priorities, and in situ recovery of shale oil. (This updated bibliography contains 148 abstracts, 120 of which are new entries to the previous edition.) See also NTIS/PS-77/0384, Oil Shale Mining, Processing, Uses, and Environmental Impacts. Vol. 1. 1964-1975.

53952 (NTIS/PS—77/0386) **Oil shale mining, processing, uses, and environmental impacts. Volume 1. 1970—1975 (citations from the Engineering Index Data Base). Report for 1970—1975.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 219p. NTIS PCN01/MF N01.

See also NTIS/PS—77/0384 and NTIS/PS—77/0385.

Exploration, mining, retorting, chemistry, thermal studies, environmental impacts, and policies relating to oil shale research are discussed. A few abstracts deal with the production of synthetic fuels from shale oil and the economics of oil shale operations. (This updated bibliography contains 212 abstracts, none of which are new entries to the previous edition.)

53953 (NTIS/PS—77/0387) **Oil shale mining, processing, uses, and environmental impacts. Volume 2. 1976-April, 1977 (citations from the Engineering Index Data Base). Report for 1976-Apr 77.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 138p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0320. See also NTIS/PS—77/0384 and NTIS/PS—77/0385.

Worldwide research on exploration, mining, retorting, chemistry, thermal studies, environmental impacts, and policies relating to oil shale research is discussed. A few abstracts deal with the produc-

tion of synthetic fuels from shale oil and the economics of oil shale operations. (This updated bibliography contains 131 abstracts, 112 of which are new entries to the previous edition.) See also NTIS/PS-77/0386, Oil Shale Mining, Processing, Uses, and Environmental Impacts. Vol. 1. 1970-1975.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 53842, 53964

53954 (PB—266040) **Optical radiation measurements: the 1973 NBS scale of spectral irradiance. Final report.** Saunders, R.D.; Shumaker, J.B. (Flathead Drainage 208 Project, Kalispell, Mont. (USA)). Apr 1977. 40p. (NBS-TN—594-13). NTIS PCA03/MF A01.

See also report dated Oct 76, PB-259639.

This note describes the measurement apparatus and techniques used in deriving the 1973 scale of spectral irradiance. The uncertainty of this scale is believed to be less than 2% in the spectral region 250 nm-500 nm and less than 1% in the spectral region 500 nm-1600 nm. This uncertainty represents a threefold improvement over the previous NBS scale of spectral irradiance. The complete derivation of the projected solid angle, which is crucial when transferring from radiance to irradiance, is given. Also described in this note is a model for interpolating the spectral irradiance at wavelengths between the wavelengths measured. Measurement details are presented and sources of error are discussed.

SITE GEOLOGY AND HYDROLOGY

53955 **Secondary changes in oil shales of the Leningrad deposit.** Levin, A.S. *Izv. Akad. Nauk SSSR, Ser. Geol.;* No. 1, 125-129(1976). (In Russian).

Sequential epigenetic changes in organic matter of the Leningrad oil shales (kerogen degradation, aromatization, and increasing bituminoid A + C, hydrocarbon, humid acid, and carbon, nitrogen, and sulfur content with decreasing hydrogen, oxygen, and chlorine content) are accompanied by metasomatic dolomitization, secondary sulfidization, calcitization, and alkalinization of the karst carbonates and are caused by thermal water rising along the fault zones.

SITE GEOLOGY

REFER ALSO TO CITATION(S) 53934

53956 **Tar sands of Canada. II.** Murata, T. (Univ., Kyoto). *Sekiyu To Sekiyu Kagaku;* **19**: No. 5, 26-30(1975). (In Japanese).

In the Athabasca region, cretaceous formations of sandstone, shale, etc. overlie unconformably upper Devonian formations consisting mainly of limestone. Tar sands are included in the McMurray formation of the lowest cretaceous. A coal specimen collected from the tar sands of the McMurray formation in the Mildred-Ruth Lakes shows the atomic ratios of hydrogen and oxygen to carbon to be on the order of 0.95 and 0.25, respectively. These values suggest that the formation was heated below 200°C.

DRILLING, FRACTURING, AND MINING

REFER ALSO TO CITATION(S) 53965

53957 (SAND—77-0979) **Hydrocode simulation of the oil shale rubblization experiment at Rock Springs Site 12.** Boade, R.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 27p. Dep. NTIS, PC A03/MF A01.

An oil shale rubblization experiment will be performed during late summer of 1977. This experiment will involve the formation of three horizontal hydrofractures in an underground oil shale bed, the introduction and subsequent detonation of a slurry explosive in two of these hydrofractures, as well as various measurements of physical events and conditions associated with the dynamic experiment and with the environment. Preliminary calculations have been made with a one-dimensional hydrocode to assess some of the dynamic aspects of the upcoming experiment. Results of these calculations are presented along with a general description of the stress wave propagation, material motion, and fracture phenomena which will occur during and just after the explosive detonation. This memo is intended to be a timely discussion of the current plan and expected results of the rubblization experiment. The one-dimensional calculations will be followed by additional calculations based on a two-dimensional approach to the problem. (10 figs) (DLC)

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 53606

53958 (LA—6795-PR) **Explosively produced fracture of oil shale. Progress report, January—March 1977.** Carter, W.J. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1977. Contract W-7405-ENG-36. 23p. Dep. NTIS, PC A02/MF A01.

Significant advances of the past three months include: a Mohr-Coulomb plasticity description has been inserted into the computer code YAQUI. The Mohr-Coulomb theory assumes that flow parameters depend heavily on mean stress, a situation known to occur in most geologic materials. Generalized analytical failure surfaces for oil shales of arbitrary density have been developed based on recent static measurements of compressive strengths and the effective-stress law of fracture for fluid-filled rocks. These expressions are being expanded to include size and strain-rate effects; they will provide a convenient tool for relating most oil-shale physical properties to density alone. Characterization of nonideal explosives has continued. Our understanding of nonideal explosive behavior from both experimental and theoretical standpoints has increased so that we believe computer codes can simulate this behavior accurately enough to specify the loading in most oil-shale explosive events. A simple new technique for measuring dynamic tensile strengths has been developed, and results for Green River oil shale have been obtained as functions of bedding orientation and density. Work is now concentrated on computer simulation of explosions and explosive effects in oil shale. In particular, several dynamic fracture criteria are being tried in the code YAQUI; these will be evaluated soon. In addition, more detailed plans are being made for the large-scale field experiments of FY78; a final design should be ready by late spring of FY77. 16 figures.

53959 **Three flow types must be considered in the design of slurry handling systems.** Draganiuk, O.B. (Syncrude Canada, Ltd., Calgary). *Oil Wkly.;* **26**: No. 46/47, 14(1975).

From Section meeting of the National Association of Corrosion Engineers; Calgary, Alberta, Canada (29 Dec 1975).

Three flow types must be considered in the design of slurry handling systems for abrasive Athabasca tar sand slurries: (1) heterogeneous flow, (2) nonuniform mixture with saltation, with particles bouncing along the pipe bottom leading to grooves at the 4 and 8 o'clock positions, and (3) nonuniform mixture with sliding bed, giving accelerated bottom wear. Extensive tests have shown 60% of solids to be in the bottom 25% of the pipe, confirmed by the characteristic grooves. The best performance has been with X42 and X52 carbon steel pipe, which is superior to hard stainless steel. Polyethylene pipe must be too thick at 160° to 180°F temperatures; steel pipe lined with polyethylene would be attractive if commercially available. Concrete pipes plug up and can only be loosened with a sledge hammer. Experience by Syncrude Canada Ltd. covering rotating pipe, fourfold increase of antiabrasive requirements with flow rate, deformation and cutting wear, sliding wear, abrasive properties, critical velocity and diameter, temperature effect, and other materials is discussed.

53960 **Method of reducing sludge accumulation from tar sands hot water process.** Baillie, R.A.; Fear, J.V.D. (to Great Canadian Oil Sands Ltd.). US Patent 3,931,006. 6 Jan 1976. Priority date 17 Oct 1974, Canada. vp.

IN SITU METHODS, TRUE AND MODIFIED

53961 (LERC/TPR—77/1) **Preliminary results from retorting Michigan Antrim shale. Technical progress report.** Martel, R.A.; Harak, A.R. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). Jul 1977. 19p. Dep. NTIS, PC A02/MF A01.

As part of a continuing in-situ oil shale research effort, the retorting characteristics of a column of mine-run shale ranging in size from fines to 2-foot-cube-sized and 4-foot-cube-sized pieces are being investigated in both 10- and 150-ton capacity, batch-type retorts, respectively. Preliminary investigations into the retorting characteristics of oil shales other than those in the Green River Formation, namely Michigan Antrim shale, have begun and this paper presents the results from the first run using this Devonian-type shale in the 10-ton retort. These results are compared to previous data compiled from Colorado oil shale tests conducted in both retorts.

53962 (UCRL—79033) **Computer model for in situ oil shale retorting: effects of input-gas properties.** Braun, R.L.; Chin, R.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Mar 1977. Contract W-7405-ENG-48. 34p. (CONF-770419—2). Dep. NTIS, PC A03/MF A01.

From 10. oil shale symposium; Golden, Colorado, United States of America (USA) (21 Apr 1977).

A one-dimensional mathematical model has been developed for simulating the chemico-physical processes involved in the concurrent, vertical retorting of a rubblized bed of oil shale. Both hot-gas retorting and combustion retorting can be simulated. The flow rate of the gas stream and the composition and temperature of both the gas stream and the shale particles are calculated as a function of time and location in the retort. The rates of recovery of oil and water from the retort are also computed. The model is used to predict commercial in-situ retorting phenomena for typical conditions of shale composition, particle size, packing fraction, and input-gas properties. The predicted effects of input-gas properties (flow rate, temperature, and composition) are examined in detail. The model indicates that a gas input of air diluted with steam or CO_2 is effective in controlling the temperature and maximizing the oil yield, without causing the large decrease in retorting rate associated with the use of a mixture of air and recycle gas. The air/steam mixture is also attractice because it yields a retort product gas with a higher heating value.

53963 (UCRL—79039) Modeling of vertical pressure distribution in large in situ retorts. Carley, J.F.; Thigpen, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1977. Contract W-7405-ENG-48. 27p. (CONF-770419—1). Dep. NTIS, PC A03/MF A01.

From 10. oil shale symposium; Golden, Colorado, United States of America (USA) (21 Apr 1977).

Deformation of oil-shale rubble and its consequent permeability loss depends upon rock pressure. This pressure distribution in oil-shale rubble columns is therefore important to modified in-situ oil extraction from oil shale. Pressure distribution in unretorted columns of oil-shale rubble has been modeled using the theory of bins. Dependence of vertical pressure on column geometry and shale properties was examined. A major finding is that, at room temperature for a given geometry and properties, pressure approaches an asymptotic limit regardless of overburden forces. The model has been extended to include variations in density and frictional properties of shale that accompany the temperature changes occurring during retorting and this expanded model has been programmed for the CDC 7600 computer. Parametric studies with this program point up the urgent need for data on the dependence of interparticle frictional properties on temperature and pressure. Directions of further development and improvement of this modeling effort are discussed.

53964 Experimental approach to in situ oil recovery from tar sands. Marchant, L.C.; Land, C.S.; Cupps, C.Q. (Laramie Energy Research Center, WY). pp 147-158 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

The reverse combustion process has several features that make it attractive as an in-situ oil recovery method for tar sands. One is the improved quality of the oil produced from the tar sand. Another is the flow of the hot produced vapors through the heated sand, which obviates the possible sand plugging by liquids as might occur with forward combustion and other thermal recovery methods. There are disadvantages, however, that could prevent successful use of the method, such as the possibility of spontaneous ignition due to low-temperature oxidation during air injection through the tar sand and the limitation on pattern size imposed by low air permeability of tar sands containing appreciable oil saturation. A field experiment will be conducted to evaluate the problems and limitations that would be encountered in attempts to apply the process on a much larger scale.

53965 Promises and problems in in-situ oil shale development. Rothman, A.J. (Univ. of California, Livermore). pp 159-168 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

A process is described for obtaining oil from oil shale by mining, creating a rubble column underground, and retorting in place. This rubble in-situ extraction process (RISE) is compared with other potential methods for extraction of oil from oil shale, and appears to have advantages in producing oil at lower cost, capital investment, environmental impact, water use and population influx. As such, the process, if successfully developed on a commercial scale, can have significant impact in increasing our oil supply. Various technical and other problems to be resolved in a development program are given.

53966 Heat transfer and product formation during the in-situ retorting of oil shale. Johnson, W.F.; Timmins, T.H. (Mobil Research and Development Corp., Dallas). pp 169-178 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

For in-situ retorts in which a bed of rubblized oil shale is retorted using an oxygen-containing gas, there are two zones of major significance. The upstream zone is the combustion zone, the downstream zone is the retorting zone. The movement of these zones through the retort is generally described as the rate of combustion front advance or the rate of retorting front advance. Model studies indicate that under some conditions the combustion front will move more slowly than the retorting front and separation of these fronts will occur. Using a given retort operated under conditions of constant rate of heat loss to its surroundings, constant oxygen flux and constant fuel concentration, the combustion front advance rate increases monotonically with the mass average particle size of the shale charge. Yield calculations show the necessity of optimizing the combustion front advance rate as a function of particle size distribution. One apparent way to increase shale oil yield in an in-situ retort is to generate a rubble bed having a smaller particle size distribution than mine-run shale, and then increase the shale heat-up rate by increasing the gas flux.

53967 In situ effort gaining momentum. *Energy Process./Can.;* **68**: No. 1, 44-46(1975).

Current activities to unlock up to 164 billion bbl of reserves in tar sands by in-situ production are the most concentrated research effort ever seen in tar sands. Current estimates place a commercial in-situ project of 125,000 bbl/day at about the same cost as the equivalent producing capacity of the Syncrude project, over $2 billion.

53968 Laboratory research on a direct heat process for this extraction. Moore, R.G.; Bennion, D.W.; Donnelly, J.K. (Calgary Univ., Alberta). *Energy Process./Can.;* **68**: No. 1, 48-56(1975).

Laboratory research on a direct heat process for this extraction from oil sands will indicate if pilot-plant testing of the process on a larger scale is warranted. Combustion technology is similar to in-situ recovery of bitumen by fire flooding. The requirement of a heat carrier for indirect heat processes would increase the complexity and cost of extraction equipment.

53969 Heavy oil recovery in the Alberta Oil sands. McIntyre, H. *Eng. J. (N.Y.);* **59**: No. 1, 61-65(1976).

A $200,000,000 top-priority, industry/government venture in development of Alberta's underground tar sands resources is to start by mid-1976, involving the Alberta Oil Sands Technology and Research Authority, established in mid-1975 and custodian of $100,000,000 in provincial research and development funding to be put up on a 50-50 basis to the most promising industry field experimental schemes for in-situ tar sands development. By the Nov. 1975 deadline, 21 proposals from seven integrated oil companies, one consortium, seven nonintegrated oil companies, and five individuals were received. The total initial bitumen in place is estimated by Alberta's Energy Conservation Board at 919 billion bbl, of which only 74 billion exists at surface mining depths, i.e., with less than 150 ft of overburden. The remaining 845 billion bbl must be tapped by drilling.

53970 Fireflooding shallow tar sands--a case history. Terwilliger, P.L. (Gulf Energy and Miner, Bakersfield, Calif). *J. Can. Pet. Technol.;* **15**: No. 4, 41-48(Oct-Dec 1976).

A field pilot test of forward combustion utilizing fracturing techniques was conducted in a shallow tar sand deposit in central Kentucky. Oil production responded to the movement of the combustion zone ten days after the fireflood was started. The average oil production was 24 barrels per day for the four months required to complete the test. The total oil production of 3100 barrels was 54% of the 5700 barrels originally in place in the pattern area. The major problems encountered were the lack of complete oxygen consumption, the unsymmetrical advance of the fireflood and the tendency of the combustion zone to move toward the top of the reservoir. 6 refs.

53971 Segamo will link Europe and Africa. Richards, R.A.C. *Gas World Gas J.;* **181**: No. 4696, 627-628, 630(Nov 1976).

A description is given of a new pipeline network whose construction design considers the European-African link. The first phase of this gas plan for Spain should bring natural gas to 12 provinces, and the second phase to 22.

53972 Fluid carrier recovery system and method. Barrett, G.M. US Patent 4,033,412. 5 Jul 1977. Filed date 18 Jun 1976. 6p.

This disclosure relates to a fluid carrier recovery system for recovering oil and like liquid deposits from an underground source wherein the oil is deposited in an unpumpable form and wherein the oil is recovered by directing into the oil deposit a carrier which will fill a large volume of the oil deposit and which will flow upwardly through a flow passage in the earth to a location adjacent or above the surface of the earth, followed by the introduction into the lower part of such volume of a solvent for the oil, the solvent having a

lesser specific gravity than the carrier and being operative on the oil to form oil-solvent droplets which float in the carrier and flow to the top of the flow passage for recovery. The carrier is preferably water and the solvent may be an inexpensive mineral spirit immiscible with water.

SURFACE METHODS

REFER ALSO TO CITATION(S) 53638

53973 (UCRL—79630) **Experimental work on oil shale at Lawrence Livermore Laboratory and predictions of retorting characteristics of oil shale.** Rothman, A.J.; Lewis, A.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Jun 1977. Contract W-7405-ENG-48. 36p. (CONF-770719—1). Dep. NTIS, PC A03/MF A01.

From 11. conference on mechanical engineering; Haifa, Israel (11 Jul 1977).

An experimental program is being carried out to advance oil-shale retorting technology. This paper summarizes some results of laboratory and pilot retorting and gives the reactions of oil-shale char with gases. A computer model of the retorting process has been compared with retort experiments and has been used to predict in situ retorts under various operating conditions. Finally, the results of a retort using Negev (Israel) oil shale are compared with those using Colorado oil shale.

53974 Effect of free calcium oxide on the yield and properties of kukersite semicoking products. Efimov, V.M.; Doilov, S.K. *Khim. Tverd. Topl.;* No. 2, 72-79(1975). (In Russian).

Addition of 0 to 15% calcium oxide decreased the yield of tar and its content of phenols. The parameters of the tar changed considerably: the density decreased, the molecular weight increased, the content of olefins in the light-medium fraction of the tar distilling to 350°C increased, the combustion temperature of the tar increased, and the content of alkylresorcinols decreased. The concentration of 3,4-benzopyrene did not change.

53975 First oil sands plant: a true pioneer project. Armstrong, J. *Energy Process./Can.;* **68**: No. 1, 22-29(1975).

A discussion of the Great Canadian Oil Sands Ltd. project covers problems in attaining an economic operation in relation to the nature of oil sand; the four functions in producing the oil, including very large open pit mining, extraction or separation of the sand and bitumen with completely new technology, upgrading of the bitumen into synthetic oil, and on-site utilities having very large requirements; and the necessity for operating the total complex as a single plant, i.e., anything but a minor disruption of the first three functions could shut down the whole operation.

53976 Processes for the production of low-ash kerogen concentrates from Baltic oil shales. Kaminskii, V.S.; Sokolova, M.S. *Tr. Nauchno-Issled. Inst. Slantsev;* **20**: 14-39(1975). (In Russian).

The study included determination of optimal parameters for centrifugal hydroclassification, flotation, and centrifugal concentration of slurries and screenings for use in developing improved schemes for producing kerogens containing 70 and 90 percent organic matter. Effective oil-shale flotation agents were combinations of mixed-type or apolar collectors with acidic or neutral frothers, especially dephenolized shale tar diesel fractions with higher alkanols or detergents and kerosine or transformer oils with higher alkanols. Flotation in inorganic salt solutions with mixed-type collectors was also done.

53977 Fort McMurray reaching explosion point. Keeley, M. *Can. Pet.;* **16**: No. 12, 30-34(Dec 1975).

A discussion covers problems in the town of Fort McMurray, Alberta, resulting from rapid population growth due to operation of the nearby Great Canadian Oil Sands Ltd. plant and construction of the adjacent Syncrude Canada Ltd. plant; and inadequate rail facilities for transportation of sulfur and coke produced at these plants and at other oil sands plants which might be built in the Athabasca area.

53978 Simple control parameter for combustion retorts. Baer, A.D.; Ryan, N.W. (Univ. of Utah, Provo). *Ind. Eng. Chem., Fundam.;* **15**: No. 1, 82-83(Feb 1976).

A relationship was developed between the retorting gas flow rate and the velocity of the deflagration wave which is applicable to maintaining a separation between the pyrolysis zone and the combustion zone in the advancing thermal wave which would assure the use of residual carbon rather than volatile material as fuel in underground retorting. The analysis shows that, for stable, steady-state combustion and pyrolysis wave, the "height of a gas transfer unit", R, should be < 1, but that for the required large value of "1", the pyrolysis zone thickness, R should approach unity. Published U.S. Bureau of Mines data from 150 ton retorting tests confirm the analysis.

53979 Process for treating oil shale. Reed, T.G. Jr. US Patent 3,939,057. 17 Feb 1976. Filed date 18 Jan 1974. vp.

A process for producing a crude shale oil and a high BTU gas comprises: feeding a mixture of a major amount of crushed oil shale and a minor amount of coal, sufficient to provide process heat which is needed in excess of that supplied by burned char, to a rotary preheater, heating said mixture to a temperature less than that at which decomposition of kerogen begins, said heating by direct contact of said mixture with a flow of hot gases, passing said preheated mixture to a rotary retort, indirectly heating said mixture to a temperature in the range of 850 to 1050°F with said hot gases, said hot gases indirectly heating said rotary prior to contacting said mixture in said preheater, taking off a vaporous overhead comprising shale oil and tar oil and leaving a char on said shale, passing said retorted mixture to a hopper, removing residual shale oil by sweeping said hopper with superheated steam, passing said vaporous overhead and stripped shale oil residual to a high temperature condenser, condensing an oil fraction at a temperature above 212°F from said vaporous overhead and said hopper residual shale oil, passing the uncondensed gases from said high temperature condenser to a low temperature condenser, condensing water from said uncondensed gas, recovering a high BTU gas, passing said mixture from said hopper to a furnace, and burning said char and unvolatized coal to produce said hot gases, which pass from said furnace, first contacting said rotary retort and then directly contacting said mixture in said preheater.

PURIFICATION

REFER ALSO TO CITATION(S) 53988

53980 Desulfurization of oil sands coke. Parmar, B.S.; Tollefson, E.L. (Univ. of Calgary, Alberta). *Can. J. Chem. Eng.;* **55**: No. 2, 185-191(Apr 1977).

Research done on the development of a process to desulfurize oil sands coke is described. Solvent extraction, steam treatment alone, steam treatment in the presence of sodium compounds, treatment with steam and air mixtures, hydrodesulfurization and preoxidation followed by hydrodesulfurization have been investigated. It has been found that oxidative pretreatment of oil sands coke with air at low temperatures enhances the rate of sulfur removal during the subsequent hydrodesulfurization. Up to 75% of the sulfur present in the oil sands coke can be removed by preoxidizing the coke at 530°F for eight hours followed by hydrodesulfurization with hydrogen at 1200°F for eight hours using shallow fluidized beds of -20 mesh coke particles. Yields of purified coke of approximately 56% were obtained from this process.

53981 Reduced nitrogen content of hydrocarbon fraction by catalytic polymerization. Holloway, R.L.; Edison, R.R.; Wachtel, S.J. (to Atlantic Richfield Co.). US Patent 4,033,861. 5 Jul 1977. Filed date 19 May 1975. 14p.

A method for producing a hydrocarbon material having a reduced nitrogen content involves contacting a nitrogen-containing hydrocarbon feedstock, e.g., crude shale oil, shale oil derived gas oil, mixtures thereof and the like, in at least one reaction zone with a catalyst to polymerize at least a portion of the contained nitrogen compounds, e.g., refractory high boiling nitrogen-containing compounds, and, thereafter, separating, e.g., flashing, the resulting reactor effluent to produce a hydrocarbon material having a reduced nitrogen content relative to the feedstock and effluent. This hydrocarbon material may be advantageously used in hydrocarbon hydrotreating. Also provided is a novel apparatus which can be used to carry out the method of the present invention.

PROPERTIES AND COMPOSITION

53982 (LA-UR—77-1005) **Analytical failure surfaces for oil shales of varying kerogen content.** Johnson, J.N.; Simonson, E.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 22p. (CONF-770706—1). Dep. NTIS, PC A02/MF A01.

From 6. AIRAPT international high-pressure conference; Boulder, Colorado, United States of America (USA) (25 Jul 1977).

Experimental data and theoretical analysis are presented for the shear strength of oil shale of arbitrary density. Experimental data show that strength increases significantly with density and confining pressure. The data exhibit a variation with sample orientation that has been ignored. The analytical representation is based entirely on compressive strength properties. Two other considerations concerning material strength of oil shale in dynamic field (large-scale) applications are rate and size effects. The rates and sample sizes for which tests were conducted in this study were on the order of 10^{-4} s^{-1} and several centimeters, respectively. Explosive loading in field applications involves rates varying from 10^{2} to 10^{6} s^{-1} and sizes on the order of hundreds of centimeters. The effect of high loading

rates is generally to increase the strength, while increasing size tends to reduce average material strength due to the greater probability of finding larger cracks and flaws in large samples. The strength-pressure-density data and analysis ignore some of these effects, but provide a useful semi-empirical relationship on which to base analyses of static and dynamic fracture of oil shale for energy resource recovery, particularly when little more than average density of the stratum or region is known. (DLC)

53983 Comparative characteristics of alcohol—benzene and ether extracts of kukersite kerogen. Urov, K.E. (Inst. of Chemistry, Tallin). *Khim. Tverd. Topl.;* No. 5, 66-67(1975). (In Russian).

The extracts yields using ethyl ether or benzene-methanol mixture 3:1 by vol were similar in amount, but the ether extract contained approximately 1.5 times more nonaromatic hydrocarbons, chiefly C_{20}—$_{35}$ n-alkanes, than the benzene-methanol extract. The difference was attributed to the greater penetration of ether into the kerogen mass and to the heterogeneity of n-alkanes in the kerogen.

53984 Study of the group and constituent composition of an alcohol—benzene extract of bituminous shale from the Boltysh deposit in the Ukrainian S.S.R. Pobul, L.; Fomina, A.S. (Inst. of Chemistry, Tallin). *Khim. Tverd. Topl.;* No. 6, 134-142(1975). (In Russian).

A study of extraction and composition used extracting agents comprising 1:1 mixtures of ethanol with benzene, dichloroethane, or pyridine. The highest yield of bituminoids was obtained with the alcohol-benzene mixture, and this extract was studied in detail. The hydrocarbon portion of the Boltysh shale appears to be characterized by C_{24}-C_{31} paraffins, mainly with an odd number of carbon atoms. The high-molecular-weight part of the shale bituminoids contains alkane chains mainly of 10 to 15 carbon atoms and only a small amount of aromatic compounds. The alkyl groups in the latter part and those in the shale kerogen have the same composition, which is close to that of the n-paraffins of the majority of petroleums.

53985 Concentration and mineralogical residence of elements in rich oil shales of the Green River Formation, Piceance Creek Basin, Colorado, and the Uinta Basin, Utah...a preliminary report. Desborough, G.A.; Pitman, J.K.; Huffman, C. *Chem. Geol.;* 17: No. 1, 13-26(1976).

Ten samples from drillcores of two rich oil-shale beds from the Parachute Creek Member of the Eocene Green River Formation, were analyzed for 37 major, minor, and trace elements. For 23 of these elements, principal mineralogical residence is established or suggested. Such studies may provide data which are useful for predicting the kinds and amounts of elements and compounds that might be released into the environment by oil-shale mining operations.

53986 Microbial utilization of raw and hydrogenated shale oils. Westlake, D.W.S.; Belicek, W. (Univ. of Alberta, Calgary). *Can. J. Microbiol.;* 22: No. 2, 221-227(1976).

The biodegradabilities of raw and hydrogenated shale oils prepared by a retort process were studied under psychrophilic and mesophilic conditions. Changes in bacterial numbers and the chemical composition of the oils were monitored using a plate count and chromatographic techniques. Raw shale oil was relatively resistant to microbial attach whereas hydrogenated shale oil was readily utilized for microbial growth. Populations enriched on raw shale oil had a reduced ability to use hydrogenated shale oil under similar conditions. Gram-negative rods predominated in all enrichment populations. To facilitate cleanup of shale oil spills, it is recommended that raw shale oil be hydrogenated at the extraction site before transport.

53987 Studies on the components in shale oil. VII. Identification of thianaphthene, naphthalene, and their methyl homologs. Iida, T.; Okumura, K. *Yakugaku Zasshi;* 96: No. 1, 37-43(1976). (In Japanese).

The 215 to 250°C fraction of Colorado shale oil was effected by redistillation into narrow subfractions labeled A, B, and C. After aliphatic hydrocarbons in fraction A were removed with silica gel, the concentrate of thianaphthene and napthhalene mixture was separated by alumina, the latter being adsorbed less strongly on alumina. The compounds were identified by NMR, uv, and ir spectra. Similarly, 6-methyl-thianaphthene, 1- and 2-methyl naphthalene, and diphenyl were isolated from fraction B and identified. Further, 2,6- and 1,6-dimethylnaphthalene were identified in fraction C.

53988 Baltic shale tars as raw materials for the production of multifunctional additives for fuels and oils. Zelenin, N.I.; Nikitin, E.E.; Fainberg, V.S. (Leningrad Eng-Econ Inst, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* 12: No. 5-6, 444-448(May-Jun 1976).

From the existing concepts as to the mechanism of antioxidant and antiwear additives, one can formulate certain basic requirements on their composition and properites. As conditions of effectiveness for multifunctional additives, the molecules must include the following: hydroxyl groups of a proton-donor character to break oxidative chains; polar groups to give the additive surface activity; double bonds in hydrocarbon chains to reinforce their adsorption effect; and relatively long hydrocarbon chains to give the additive solubility in fuel or oil. The present work was aimed at determining to what degree the compounds of Baltic shale oils meet these conditions. Experimental data are presented which show that the oxygen-containing compounds of shale oils represent a highly polar system of compounds that tend to form hydrogen bonds, the system having hydroxyl groups and relatively long hydrocarbon chains in which a double bond is frequently encountered. These features of composition and properties of the Baltic shale oils make them effective raw materials for the production of antioxidant, antiwear, and anticorrosion additives for fuels and lubricating oils. 12 refs.

53989 Mercury in oil shale from the Mahogany Zone of the Green River Formation, eastern Utah and western Colorado. Donnell, J.R.; Shaw, V.E. *J. Res. U.S. Geol. Surv.;* 5: No. 2, 221-226(Mar-Apr 1977).

Mercury has been reported in concentrations as high as 4 parts per million from oil shale in the Green River Formation near the Federal oil-shale prototype lease-tracts U-a and U-b in eastern Utah. This high concentration of mercury if present throughout a minable zone, would be of concern in commercial oil-shale operations processing large volumes of shale. Using an improved analytical method, surface samples from eastern Utah previously reported to contain high concentrations of mercury were reanalyzed, and an additional 183 drill core samples from the Mahogany zone and adjacent beds were analyzed. The reanalyzed samples averaged slightly more than 0.35 ppm mercury and the drill-core samples averaged 0.37 ppm. The products from a Fischer assay of 100-gram sample of oil shale, found to yield 35 gallons per ton of oil and 43 ppm of mercury, were analyzed for their mercury content. The spent shale contained only 2 percent of the total mercury in the assay products and the gas fraction contained about 58 percent. 4 refs.

53990 Chemical composition of gases in Athabasca bitumen and in low-temperature thermolysis of oil sand, asphaltene and maltene. Strausz, O.P.; Jha, K.N.; Montgomery, D.S. (Univ of Alberta, Edmonton). *Fuel;* 56: No. 2, 114-120(Apr 1977).

Athabasca oil sand on degassing in vacuo releases gases volatile at -78°C which are composed of neopentane, methane, acetaldehyde, propane and propylene. At elevated temperature, 70--210°C, additional quantities of these materials are produced by thermolysis. The activation energies of product formations were determined: they all have unusually low values, pointing to a catalytic effect of the mineral matter present. These results clearly suggest a thermal rather than a microbial origin for the volatile materials present in the oil-sand formations. 9 refs.

53991 Investigations on Romashkino asphaltic bitumen--1. use of ion-exchange and adsorption chromatography for the separation of maltenes. Boduszynski, M.; Chadha, B.R.; Pineles, H. (Pol Akad Nauk, Gliwice). *Fuel;* 56: No. 2, 145-148(Apr 1977).

Use has been made of ion-exchange resins to remove acid and base fractions from maltenes originally separated from Romashkino asphaltic bitumen. The effect has been studied of the ion-exchange resin treatment on the group-type composition of maltenes using adsorption chromatography through alumina. Yields, elemental and densimetric analyses of subfractions obtained have been given. 15 refs.

53992 Investigations on romashkino Asphaltic bitumen. II. Study of maltenes fractions using inverse gas-liquid chromatography. Boduszynski, M.; Szkuta-Pochopien, T. (Pol Akad Nauk, Gliwice). *Fuel;* 56: No. 2, 114-120(Apr 1977).

The effectiveness of the separation of maltenes by ion-exchange chromatography has been ascertained. Results of analysis by IGLC indicated significant variation in interaction coefficient values of the fractions. Acidic and basic fractions were shown to interact strongly with test compounds. 9 refs.

DIRECT USES AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 53988

HEALTH AND SAFETY

53993 (PB—265360) Industrial hygiene survey of the Paraho oil shale mining and processing facilities. Summary report 23 Dec 74-7 Sep 76. Holland, W.D. (LFE Environmental Analysis Labs., Richmond, Calif. (USA)). 7 Sep 1976. Contract J0255001. 14p. NTIS, PC A02/MF A01.

LFE Corp. performed an industrial hygiene survey of the Paraho oil shale mining and processing facility in Anvil Points near Rifle, Colo., on August 6-7, 1975. This survey consisted of an

investigation of the underground operations for diesel emission contaminants and of the aboveground work areas for all inhalation contaminants other than silica dust, NO_2, NO, H_2SO_4, formaldehyde, CO_2, SO_2, and CO. None of the determinations of contaminants in the underground operations indicate air concentrations exceeding their standards. The results of the samples collected aboveground indicate only one welding operation, where the standards for total dust and lead are exceeded, where the employee's exposure exceeds the standards. Since the survey, the employer has installed an exhaust ventilation system that has significantly reduced the welder's exposure.

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 53989

FISSION FUELS

REFER ALSO TO CITATION(S) 54649, 54690

RESERVES

REFER ALSO TO CITATION(S) 53606, 54674

53994 Uranium resources 1975—2000: reserves, resources and exploration potential in the United States. Brookins, D.G. (Univ. of New Mexico, Albuquerque). pp 9-15 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

In terms of the minimum anticipated cumulative demand, our uranium reserves are not adequate to meet the projected demand. The most abundant uranium deposits are those classified as Peneconcordant Deposits, in which the uranium is concentrated, commonly in close association with organic carbonaceous matter, in fluvial, lacustrine, and near-shore marine deposited sandstones interbedded with mudstones. Uranite (uranium oxide) and coffinite (uranium silicate) are the main ore minerals; they commonly fill voids in the sandstones but occasionally replace older mineral grains. The average grade of ore is 0.15 to 0.30 percent U_3O_8 with a cutoff of 0.08 percent. The ore is deposited in various geometries with tabular or lensoid masses and crescent-shaped "rolls" being the most common. The deposits are sporadically distributed within the sandstones and are commonly quite small, although large accumulations (e.g., 10 million tons of ore) are known. Conditions of formation for these deposits are not known although it is speculated that deposition of uranium occurs at redox interfaces in ground water systems. Uranium is thought to be transported as hexavalent uranyl dicarbonate ion which is reduced to tetravalent U in uraninite or coffinite concomitant with formation of pyrite and possibly other minerals. The sandstone-type of deposits constitute over 95 percent of the deposits known in the United States and are more or less restricted to certain geographic areas. Other deposits include Precambrian, uranium-bearing quartz conglomerates (important in Canada and South Africa but not in the United States), uranium-bearing vein deposits which occur as fissure and other types of fillings of rocks of virtually all ages, contact metamorphic deposits, and other minor deposits. The possibilities of finding more uranium deposits in the USA are considered in some detail.

53995 Ore genesis influenced by compaction, ch. 5. Uranium deposits in sediments. Wolf, K.H. (Watts, Griffis and Mc Quat Ltd., Jeddah (Saudi Arabia); Directorate General of Mineral Resources, Jeddah (Saudi Arabia)). pp 591-625 of In Compaction of coarse-grained sediments, 2. Chilingarian, G.V.; Wolf, K.H. (eds.). Amsterdam, Netherlands; Elsevier (1976).

A simple conceptual model of the genesis of the sandstone-type uranium ores developed by the author is presented. The theory of ore genesis by compaction fluids which is outlined in the rest of the chapter renders the basic ideas for the model. The principal related aspects of compaction are porosity and permeability. These and other aspects and their relationships are investigated.

53996 (LA-tr—77-40) Using geochemistry to assess the extent and frequency of phenomena of the Oklo type. Roth, E.; Lucas, M.; Lecomte, T.; Devillers, C.; Hagemann, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). 1977. Translation of IAEA-SM—204/25. (CONF-750641—7). 14p. Dep. NTIS, PC A02/MF A01.

From IAEA international symposium on the Oklo phenomenon; Libreville, Gabon (23 Jun 1975).

The group of natural nuclear reactors discovered at Oklo is the only one known at present. This leads one to wonder whether the phenomenon is a highly exceptional one or whether such nuclear reactions were frequent in the past. Judging by the conditions necessary for them to become established, such reactions could have taken place only in fairly remote times (probably over 1000 million years ago), when the concentration of ^{235}U in natural uranium was a few percent. If, prior to those times, an appreciable fraction of the natural uranium underwent fission chain reactions and the products were redistributed in the earth's crust, the present isotopic composition of the elements which are abundant in fission might be different from the original composition. It would be characterized by a higher concentration of isotopes resulting from fission. Selenium, ruthenium, palladium and tellurium, which are rare in the earth's crust and abundant in fission, would be the elements most likely to experience changes in isotopic composition as a result of such phenomena. Efforts to estimate the order of magnitude of the concentrations of fission-product elements likely to cause detectable isotopic abundance variations has led to a study, in the first place, of ruthenium as a means of finding an upper limit for the extent of the fissions which occurred. For this purpose, chemical and isotopic determinations of ruthenium in very old ores have been performed.

53997 New types of deposits will provide future supplies of uranium. Derry, D.R. (Derry, Michener and Booth). *Can. Min. J.;* **98**: No. 3, 56-58, 60(Mar 1977).

The principal aspect dealt with in this article is the trend of relative importance of the different types or classes of uranium deposits that constitute present and future world reserves. Changes can be noted in the percentages of uranium production provided by the various classes of deposit. 7 refs.

EXPLORATION

REFER ALSO TO CITATION(S) 53994

53998 Regional geochemical uranium prospecting in Finland. Bjoerklund, A.J. (Geological Survey of Finland, Espoo); Tenhola, M. (Helsinki Univ. (Finland)); Rosenberg, R. (Technical Research Centre of Finland, Espoo). pp 283-295 of In Exploration for uranium ore deposits. Vienna; IAEA (1976).

From Symposium on exploration of uranium ore deposits; Vienna, Austria (29 Mar - 2 Apr 1976).

Organic-rich lake sediments were sampled over a 6000-km^2 area in Karelia, eastern Finland. In addition to several smaller anomalies, the investigation indicate an extended zone of anomalously high uranium in lake sediments along the contact between Karelian schists and Pre-Karelian rocks. Loss on ignition correlated with the uranium content. Two methods of calculating uranium content with respect to the organic material were investigated. The distribution of uranium in the sediments of individual lakes was studied. It was found that central lake samples may fail to indicated isolated mineralizations in adjacent bedrock. A comparison between lake and stream sediments indicated that stream sediments may be used to complement lake sediment grids in areas of low lake density.

53999 (LA—6804-PR) Geostatistics project of the National Uranium Resource Evaluation program, January—March 1977. Bement, T.R.; Susco, D.V.; Whiteman, D.E.; Zeigler, R.K. (Los Alamos Scientific Lab., N.Mex. (USA)). May 1977. Contract W-7405-ENG-36. 31p. (GJBX—50(77)). Dep. NTIS, PC A03/MF A01.

Data collected by Geodata International, Inc., on the air reconnaissance of the 1° x 2° Lubbock Quadrangle were analyzed. These data, on magnetic tapes, were transferred to the LASL System 2000 data base management system. Regions of favorable mineralization were then delineated using "Robust," "Clustering," and Linear Discriminant techniques. Data for three map lines were plotted to show the trend of ^{214}Bi vs ^{208}Tl within geological formation and within the 1° x 2° Lubbock Quadrangle.

54000 (LA—6840-PR) NDA technology for uranium resource evaluation. Progress report, January 1—March 31, 1977. Menlove, H.O. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1977. Contract W-7405-ENG-36. 21p. Dep. NTIS, PC A02/MF A01.

The work has focused on gamma-ray calculations and computer code modifications in support of borehole logging measurements and surface gamma-ray surveys. The major modifications have been completed on the gamma-ray transport computer codes at the Los Alamos Scientific Laboratory (LASL) to give the fine energy group resolution desired for the uranium calculations. Monte Carlo calculations have been compared with discrete ordinates ONETRAN calculations to gain confidence in the results and to check absolute flux values. To permit the many-group ONETRAN calculations to be performed in a more convenient and efficient manner,

the MIXCB code has been developed to give mixed cross-section files corresponding to the various rock compositions, and the ONEPLT code provides the capability of displaying the results in a variety of formats. Preliminary studies have been performed to determine appropriate values of the ONETRAN parameters P/sub n/ and S/sub n/ for this configuration. In support of the Geodata International, Inc. measurement program, supplementary calculations have been performed to determine the effect of varying ground moisture on the KUT gamma-ray spectra. Feasibility studies are continuing to investigate the use of a photoneutron source for direct measurement of the uranium concentration surrounding a borehole. A ^{124}Sb-Be neutron source and a ^{4}He gas proportional counter for counting the induced prompt fission neutrons were used for the initial laboratory test experiments. A ^{235}U fission chamber has been used to map the neutron flux from the ^{124}Sb-Be interrogation source in sand, and a small ^{252}Cf source was used to measure the spatial dependence of the response from the ^{4}He fast-neutron detector.

54001 (SAND—77-0336) **Status report on the development of a prompt fission neutron uranium borehole logging technique.** Smith, G.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). May 1977. Contract EY-76-C-04-0789. 57p. Dep. NTIS, PC A04/MF A01.

The prompt fission neutron (PFN) method of direct uranium measurement was studied. The PFN uranium logging technique measures the enhanced epithermal neutron population created by the prompt thermal fission of ^{235}U to assay uranium mineralization around a borehole. This neutron population exists for several hundred microseconds after a pulsed neutron source produces a burst of high energy (14 MeV) neutrons. A feasibility study established the basic relationship between the uranium concentration and the enhanced epithermal neutron count, and defined the major measurement perturbing factors. Following the feasibility study, development of a PFN prototype field probe was undertaken. A laboratory type neutron generator, the Controlatron, was modified for use in the probe. Field evaluation of the prototype system began in January 1976. Comparisons of neutron logs and natural gamma logs taken during this evaluation period clearly define many disequilibrium conditions as verified by ore grade estimates from core samples. The feasibility of the PFN logging technique to detect uranium in-situ has now been demonstrated.

54002 Use of till in geochemical uranium exploration. Bjoerklund, A.J. (Geological Survey of Finland, Espoo). pp 297-309 of In Exploration for uranium ore deposits. Vienna; IAEA (1976).

From Symposium on exploration of uranium ore deposits; Vienna, Austria (29 Mar - 2 Apr 1976).

The usefulness of till geochemistry in the semiregional and follow-up stages of uranium exploration was studied. With sampling at a desity of 10 sites/km^2, restricted uranium anomalies in glacial drift were outlined within large areas of anomalous uranium contents found in lake sediments. In supplementary sampling at a higher density and subsequent sampling of drift and bedrock by power drilling, uranium-mineralized bedrock was successfully located. Sampling over mineralizations at Paukkajanvaara indicated that anomalous uranium in the drift is of hydromorphic origin. Studies of the different grain-size fractions of drift sampled in follow-up work in other areas showed that anomalies, at least in part, may have a mechanical genesis. Sampling at depths less than 1 m may fail to indicate mineralizations, presumably because uranium is leached out from dry surface-drift profiles.

54003 Car-borne prospecting methodology. First results from the Cuenca del Nordeste (Uruguay). Goso, H.; Spoturno, J.; Preciozzi, F. (Ministerio de Industria y Energia, Instituto Geologico "Ing. Eduardo Terra Arocena", Comision Nacional de Energia Atomica, Montevideo, Uruguay). pp 531-543 of In Exploration for uranium ore deposits. Vienna; IAEA (1976). (In Spanish)

From Symposium on exploration of uranium ore deposits; Vienna, Austria (29 Mar - 2 Apr 1976).

The paper reports on a prospecting procedure used in Uruguay for the selection of areas of interest and on the first results obtained in the Cuenca del Nordeste (North-East Basin). The methodology developed (preliminary radiometric investigation) consists of four successive stages: compilation of material; radiometric survey; statistical analysis; revision of anomalies. The compilation of material has the aim of obtaining geological and cartographic data and of laying out the network of tracks of the area to be prospected. The radiometric survey provides data by means of a car-borne recording scintillometer, together with geological information necessary for preparing the geological map. By statistical analysis of the results it is possible to define and quantify various types of anomalies in a simple manner. Use of a log-normal model yielded a highly logical and coherent approximation in the treatment of the data obtained, and a classification of the defined anomalies in order of importance. Anomaly revision is carried out on first and second order anomalies, and on those of the third order deemed to be significant. This methodology has been developed and is in use on sedimentary formations of the Devonian, Gondwana and Cretaceous, where there are various problems presented by the overburden and the grid size ranges between 1 km and 4-8 km^2. In the particular case of the Cuenca del Nordeste (Gondwana), with no background of uranium mineralization, it was possible to select a zone of some 1000 km^2 in the San Gregorio-Tres Islas formation with a view to carrying out more detailed work.

54004 Uranium exploration by borehole gamma-ray spectrometry using off-the-shelf instrumentation. Killeen, P.G.; Bristow, Q. (Geological Survey of Canada, Ottawa, Ontario). pp 393-413 of In Exploration for uranium ore deposits. Vienna; IAEA (1976).

From Symposium on exploration of uranium ore deposits; Vienna, Austria (29 Mar - 2 Apr 1976).

During the 1975 summer field season, two Canadian manufacturers offered borehole gamma-ray spectrometric equipment which was essentially a modified version of their portable instrument designed for surface measurement. The operation of both portable gamma-ray spectrometry systems was tested in boreholes at locations near Ottawa, Elliot Lake, and the Bancroft area. The off-the-shelf instruments, interfaces, borehole probes, cables, winches, recorders, and associated equipment are described and compared. Methods of operation, and of calibration, their relative advantages and disadvantages, and results of borehole measurements are given for both sets of equipment. In addition, 1024 channel gamma-ray energy spectra from the three available borehole probes with NaI(T1) crystals of sizes 3/4x2 in., 3/4x3 in., and 1x3 in., were recorded in the laboratory. The low efficiency of such crystals for high-energy gamma rays is readily apparent from these spectra, and also from spectra recorded in the boreholes in the Bancroft area. Sample recordings of K, U, Th and total count logs were made in the same hole with the three probes, for comparison. An attempt is made to give an appreciation of the problems involved, typical count-rates to be expected, and suggestions are made for future modifications in equipment and technique to overcome some of the difficulties encountered.

54005 Exploration for uranium in southwestern Anatolia. A case history. King, J.; Tauchid, M.; Frey, D.; Basset, M. (International Atomic Energy Agency, Vienna (Austria)); Cetinturk, I.; Aydonoz, F.; Keceli, B. (Maden Tetkik ve Arama Enstitusu, Ankara (Turkey)). pp 501-528 of In Exploration for uranium ore deposits. Vienna; IAEA (1976).

From Symposium on exploration of uranium ore deposits; Vienna, Austria (29 Mar - 2 Apr 1976).

The present project, a UNDP/IAEA technical assistance project with the Turkish Mineral Exploration and Research Institute, seeks unoxidized ore in the reduzate zone below the water table in southwestern Turkey. It employs a multi-method attack that utilizes reconnaissance geological mapping, scintillometer surveys, stream sediment surveys, water sampling for uranium and radon, rotary non-core drilling, multielement geochemical laboratory analysis of field samples, radiometric determinations for secular equilibrium, and computer treatment of the results. Ideally, the initial stages would include both radiometric surveys and reconnaissance geological mapping; the mapping also provides basic stratigraphic and structural control for drilling. More detailed follow-up surveys in anomalous areas consist of a scintillometer survey, soil gas (Rn), and soil geochemistry on a predetermined grid, and a detailed hydrogeochemical survey where numerous wells exist. The geochemical investigations are supported by a laboratory in Ankara that can perform over 1000 determinations a day with a five-man team. Non-core rotary drilling with 1-m samples of cuttings, together with gamma, spontaneous potential, and resistance logs provide adequate sub-surface information. About 25000 m have been drilled by the equivalent of two rig years. Only four holes have been cored for mineralogical and equilibrium information. Drilling to a nominal 100-m depth is accomplished to determine the stratigraphy and to evaluate the area for uranium favourability. Particular attention is given to carbon and pyrite content and to the possibility of redox interfaces. Mineralized zones have been penetrated in two areas. At one, the lead was a possible redox interface. The favourability of the area was confirmed by later geochemical surveys. At the other area, drilling was stimulated and guided by hydrogeochemical anomalies.

54006 Remote sensing in uranium exploration. Offield, T.W. (Geological Survey, Denver, Colo. (USA)). pp 731-743 of In Exploration for uranium ore deposits. Vienna; IAEA (1976).

From Symposium on exploration of uranium ore deposits; Vienna, Austria (29 Mar - 2 Apr 1976).

New types of multispectral data and computer enhancement of images provide a basis for quantitative analysis of ground reflectance, color discrimination and removal of illumination-geometry effects, not possible with standard aerial photographs. These methods can be designed to take advantage of spectral characteristics of minerals such as hematite and limonite in attempting to discriminate areas of alteration around mineral deposits. The spectral bands of Landsat are not optimum for this discrimination, but several studies show that enhancement of Landsat images permits effective mapping of altered ground in some areas. Red and yellow ground may be confused, a problem where only one of these colours marks alter-

ation related to mineralization. Altered ground in uranium areas has been successfully defined at Cameron, Arizona and Crooks Gap and the Powder River Basin in Wyoming. The Wyoming studies, described in some detail, resulted in unambiguous discrimination of red alteration at Crooks Gap but only partial distinction of red altered ground from yellow-weathering areas in the Powder River Basin. In South Texas, heavy vegetation severely limits the detection of reflectance differences in geological materials or of structural features. Thermal-infrared images of the Texas area aid in detection and mapping of channel-fill deposits, potential loci of uranium mineralization in the Miocene Catahoula Tuff.

54007 Studies on thorium and uranium disequilibrium on the surface layers of the coastal sediments and their absolute concentrations in the sediments. Joshi, L.U.; Ganguly, A.K. *J. Radioanal. Chem.;* **34**: No. 2, 299-308(1976).

3 figs.; 8 refs.; 3 tabs.

Measurements of thorium and uranium isotopic activity ratios have been carried out with top layers of the sediments of the West coast of India in order to understand the behaviour and distribution of these isotopes in the coastal region. The southern part of the West coast contains a large amount of placer deposits while the northern region is free from such deposits. It is observed that thorium concentrations both in the leached fraction and in the core are quantitatively much higher in samples from monazite bearing areas than of the respective fractions in nonmonazite areas. A similar behaviour is also observed for the distribution of uranium. The absolute values of leachable uranium are generally lower than that obtained for thorium. In the nonmonazite areas, the percentages of the leachable fraction in the sediments are much higher for thorium than uranium. This can be explained on the basis that uranium is better solubilised from the sediment surface in ambient sea water than thorium and there is preferential pick-up of thorium on the sediment particles.

54008 Comparison of some analytical techniques for determining uranium, thorium, and potassium in granitic rocks. Stuckless, J.S.; Millard, H.T. Jr.; Bunker, C.M.; Nkomo, I.T.; Rosholt, J.N.; Bush, C.A.; Huffman, C. Jr.; Keil, R.L. *J. Res. U.S. Geol. Surv.;* **5**: No. 1, 83-91(Jan-Feb 1977).

Use of seven different techniques and four different treatments of the fluorometric method to analyze for uranium in granitic rocks and of four analytical techniques for thorium and three analytical techniques for potassium, two elements that are commonly present in anomalous amounts within uranium provinces is discussed. Results show that commonly used techniques for thorium and potassium determinations are both adequately precise and accurate, but that many techniques used for uranium determinations lack the necessary precision or accuracy for complete geochemical prospecting. A combination of delayed-neutron determinations for uranium and γ-ray spectrometric analyses for radium equivalent uranium, thorium, and potassium provides the best data base for geochemical exploration for uranium. If more detailed interpretations are desired, the combination of γ-ray spectrometry and α-spectrometry may be best. Carefully done fluorometric analyses should be adequate for water, ore, mineralized rock, and other applications where high precision and accuracy are not required. 16 refs.

54009 Uranium, how to find it. Distel, B.W. (NUS Corp). *Min. Congr. J.;* **63**: No. 2, 38-42(Feb 1977).

Known uranium reserves can be consumed readily by existing, or soon to be constructed, nuclear power units. The needs of additional nuclear units being planned or considered to contribute to future electrical demand may well exceed 15 times today's known reserves. It is timely to reflect on uranium and how to find it, because this subject stands likely to be a prime concern for many years.

FEED PROCESSING

54010 Yellow cake for the future. James, H.E.; Boydell, D.W. *Nucl. Act.;* No. 15, 3-7(Jul 1976).

With the demand for uranium growing at an increasingly rate as nuclear power is installed world-wide, greater extraction efficiency and new technologies for the exploitation of lower and lower grade ores have become almost mandatory. The Extraction Metallurgy Division of the Atomic Energy Board in collaboration with other organisations, has long been active in research in this area and has progressively developed improved processes for uranium extraction.

54011 Battle of the dumps continues. *S. Afr. Min. Eng. J.;* **88**: No. 4122, 19,23,27,33(Nov 1976).

Although East Rand Gold and Uranium Company is about to start exploitation of the old slimes dams to produce gold, uranium, and sulphuric acid, the battle to suppress dust and establish vegetation on the old dumps continues. The physical problems, planning, co-ordination and legal aspects of mine dump reclamation are outlined.

54012 Method for converting UF_5 to UF_6 in a molten fluoride salt. Bennett, M.R.; Bamberger, C.E.; Kelmers, A.D. (to Energy Research and Development Administration). US Patent 4,005,178. 25 Jan 1977. Filed date 10 Jul 1975. 6p.

PAT-APPL-594,823.

The reduction of UF_5 to UF_4 in a molten fluoride salt by sparging with hydrogen is catalyzed by metallic platinum. The reaction is also catalyzed by platinum alloyed with gold reaction equipment.

54013 CIX uranium process: Blyvoors leads the way with full conversion. *S. Afr. Min. Eng. J.;* 27, 31, 67(Mar 1977).

The Atomic Energy Board has developed a promising technique, the continuous ion exchange(CIX) process, for the recovery of uranium. The Blyvooruitzicht Gold Mining Company, which accommodated the highly successful demonstration plant is now spending R10 500 000 on extentions and conversions to full CCD/CIX. This article outlines the system and its advantages.

54014 Process for producing uranium oxide rich compositions from uranium hexafluoride using fluid injection into the reaction zone. Colter, J.C.; James, D.B.; Keith, W.G.; Akbari-Kenari, R. (to General Electric Co.). US Patent 4,031,029. 21 Jun 1977. Filed date 2 Jul 1975. 10p.

An improved process for the conversion of gaseous uranium hexafluoride to a uranium oxide rich composition in the presence of an active flame in a reaction zone is achieved by introducing a first gaseous reactant comprising a mixture of uranium hexafluoride and a oxygen-containing carrier gas and a second gaseous reactant comprising a reducing gas, the reactants being separated by a shielding gas as introduced to the reaction zone. The shielding gas temporarily separates the gaseous reactants and temporarily prevents substantial mixing and reacting of the gaseous reactants. The flame occurring in the reaction zone is maintained away from contact with the inlet introducing the mixture to the reaction zone. The process also includes introducing an oxygen-containing gas as a third gaseous reactant at a time when the uranium hexafluoride conversion to uranium dioxide is substantially complete resulting in oxidizing the uranium oxide composition to a higher oxide of uranium and conversion of the residual reducing gas to its oxidized form. During the process there is practiced the improvement of introducing an atomized fluid having a high latent heat of evaporation so that the atomized fluid directly enters the reaction zone and the introduction can be made at a location so that the atomized fluid enters the primary flame, the secondary flame, or both the primary and secondary flames, or downstream from the secondary flame. The atomized fluid can be introduced alone or with a carrier gas such as an oxygen-containing gas.

ENRICHMENT

54015 Gas separation nozzles and method and apparatus for producing such nozzles. Tybus, G.; Ebner, L.; Waldhoeer, R.; Bichler, P.; Bier, W.; Happe, P.; Weis, F. (to Messerschmitt-Bolkow-Blohm GmbH). US Patent 4,033,021. 5 Jul 1977. Priority date 20 Apr 1974, German, Federal Republic of (F.R. Germany). 10p.

Gas separation nozzles are produced by machining the nozzle parts, such as a holding body and separation elements by moving sectional material, for example, prefabricated sectional steel or aluminum alloy rods through a high precision sliding guide path past a shaving tool, whereby the workpiece is pressed against supporting and retaining surfaces of the guide path at least at three points and a shaving tool is applied to the moving workpiece in an area defined by said three points so that the tool is effective as close as possible to the pressure applying points or areas. At least two separation elements are supported in a dovetail groove of a holding body so that nozzle edges of the elements extend into a gas deflection groove in the holding body. Where four separation elements are held in a common dovetail groove of the holding body, two of the four elements are provided with a gas deflection groove extending along its respective nozzle edge. The arrangement is such that the nozzle edges of one pair of separation elements extend into the gas deflection groove of the other pair and vice versa. The holding body may be provided with assembly means such as further dovetail grooves and tongues for assembling a plurality of such separation nozzles into an integral structure.

GASEOUS DIFFUSION

54016 Challenge to those in instrumentation related to productivity and measuring power usage. Steinhauer, H. Jr. (Goodyear At Corp, Piketon, Ohio). *Adv. Instrum.;* **31**: 1-11(1976).

With the development of micro-modules and micro-processors, those in instrumentation are challenged to employ the princi-

ples of the Incremental Power Demand Computer (IPDC) to better utilize electric power in many applications. The IPDC was developed at the Portsmouth Gaseous Diffusion Plant in 1959 for measuring 2,000,000 Kw demand and to better utilize electric power in the production of enriched uranium. Two generations of the instruments have been used during the past 17 years to aid in the measurement and control of power usage and will be similarly used in the future when the plant load will be increased to 2,260,000 Kw. The second generation IPDC measures in and out flow on 26 meters to accurately account for transfer of power through the plant substations from one power system to the other, as well as for the power utilized by the plant. This system also prints out the hourly load on each of the meters and is utilized for calculating the multi-million dollar electric power bill each month. The second-generation IPDC uses solid-state components mounted on printed circuit boards for reliability. Pulses from the special pickups in the billing watt-hour meters are used by the IPDC to determine and display accurate plant power usage every six minutes. Application of these IPDC principles to many existing watt-hour meters would result in the better utilization of electric power. 4 refs.

CENTRIFUGATION

54017 Centrifugal separator cascade connected in zigzag manner. Kai, T.; Inoue, Y.; Oya, A.; Nagakura, M. (to Mitsubishi Heavy Industries, Ltd., Tokyo (Japan)). Japanese Patent 1976-75898/A/. 27 Dec 1974. 4p. (In Japanese).

Centrifugal separators are connected in zigzag fashion by using a single header for each stage so that in a rectangular shape the entire cascade is arranged.

54018 Influence of additional gases and impurities on the pressure distribution of uranium in the plasma centrifuge. McClure, J.J.; Nathrath, N. (Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany, F.R.)). *Verh. Dtsch. Phys. Ges.;* No. 3, 667(1977). (In German).

From Meeting on plasma and high-speed physics of the Deutsche Physikalische Gesellschaft e.V.; Essen, Germany, F.R. (7 - 10 Mar 1977).

Short communication only.

54019 Measurements on a rotating uranium arc. Nathrath, N. (Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany, F.R.)). *Verh. Dtsch. Phys. Ges.;* No. 3, 668(1977). (In German).

From Meeting on plasma and high-speed physics of the Deutsche Physikalische Gesellschaft e.V.; Essen, Germany, F.R. (7 - 10 Mar 1977).

Short communication only.

54020 Ultracentrifuge in the Netherlands. Objections against the expansion of the ultracentrifuge enrichment plant at Almelo. *Wet. Samenleving;* No. no. 2, 3-26(Feb 1977). (In Dutch).

This article contains the complete advice which was compiled by a group of energy experts on behalf of the Dutch political party PPR. In their conclusions, the authors state that the expansion of the Ultracentrifuge plant in Almelo means: Dutch support to the furtherance of the proliferation of nuclear weapons by West-Germany; Dutch financial and technical support to the expansion of the nuclear technology of West-Germany; the decrease of the future possibilities of an effective international treaty against the proliferation of nuclear weapons; a stimulation to use nuclear energy as an energy source which is dangerous and unnecessary.

LASER EXCITATION

54021 (LA—6805-C) Lasers for isotope separation, Albuquerque, New Mexico, May 17—19, 1977. (Los Alamos Scientific Lab., N.Mex. (USA)). May 1977. Contract W-7405-ENG-36. 46p. (CONF-770567—(Absts.)). Dep. NTIS, PC A03/MF A01.

From Conference on lasers for isotope separation; Albuquerque, New Mexico, United States of America (USA) (17 May 1977).

Abstracts from the papers presented at the conference are compiled. (LK)

54022 Method of isotope enrichment. Stehle, H. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,443,216/A/. 25 Mar 1976. 7p. (In German). 2 figs.

A variation of a method for isotope enriching by a laser beam is proposed, improving the selectivity and with it the economy of the method by excluding undesired reactions due to thermal activation as far as possible. The method according to the invention is divided into single steps the duration of which is limited. It is explained in detail on the example of an isotope mixture of UF_6.

54023 Method for selective isotope separation. Niemann, H.J.; Schuster, E.; Kersting, A. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,452,244/A/. 6 May 1976. 5p. (In German).

1 fig.

A method for the preparation of the selective separation of certain isotopes or isotope compounds from an isotope mixture is proposed, in which the selective excitation is effected by infra-red lasers. This is done by increasing the population of the rotational states of the mixture on the band edge of the infra-red absorption spectrum. This can be carried out by heating the isotope mixture to at least 400 K or by loading the isotope mixture through the resonant cavity of a microwave generator. The mixture with more strongly populated rotational states is then irradiated with laser frequencies in the region of the material-dependent absorption frequency to be assigned to the band edge.

54024 Isotope separation using vibrationally excited molecules. (to Jersey Nuclear-Avco Isotopes, Inc., Bellevue, Wash. (USA)). Netherlands Patent 7,607,070/A/. 28 Jun 1976. 21p. (In Dutch).

Priority 30 Jun 1975, USA; 6 figs.

A system for isotope separation or enrichment is disclosed wherein molecules of a selected isotope type in a flow of molecules of plural isotope types are vibrationally excited and collided with a background gas to provide enhanced diffusivity for the molecules of the selected isotope type permitting their separete collection. The system typically is for the enrichment of uranium using a uranium hexafluoride gas in combination with a noble gas such as argon. The uranium hexafluoride molecules having a specific isotope of uranium are vibrationally excited by laser radiation. The vibrational energy is converted to a translation energy upon collision with a particle of the background gas and the added translation energy enhances the diffusivity of the selected hexafluoride molecules facilitating its condensation on collection surfaces provided for that purpose. This process is periodically interrupted and the cryogenic flow halted to permit evaporation of the collected molecules to provide a distinct, enriched flow.

54025 Isotope separation. Morrey, J.R.; Bartlett, R.J. (to Energy Research and Development Administration). US Patent Application 727,560. 29 Sep 1976. 15p.

A method and apparatus is described for separating gas molecules containing one isotope of an element from gas molecules containing other isotopes of the same element in which all of the molecules of the gas are at the same electronic state in their ground state. Gas molecules in a gas stream containing one of the isotopes are selectively excited to a different electronic state while leaving the other gas molecules in their original ground state. Gas molecules containing one of the isotopes are then deflected from the other gas molecules in the stream and thus physically separated.

54026 Method and apparatus for measuring vapor flow in isotope separation. Janes, G.S.; Litzenberger, L.N. (to Jersey Nuclear-Avco Isotopes, Inc.). US Patent 4,024,399. 17 May 1977. Filed date 6 Jan 1975. 6p.

PAT-APPL-538,922.

A probe for detecting the evaporation rate of an electron beam evaporation source and for monitoring induced ionization of the vapor is claimed. A negatively biased electrode responds to ions in the vapor to measure the ion current density. The ions measured may result from the process of vaporization or from laser produced isotopically selective ionization. The probe provides a current output which is detected as an indication of vaporization or laser ionization rate.

54027 Method and apparatus for separating uranium isotopes. Bernstein, E.R. (to Research Corp.). US Patent 4,032,419. 28 Jun 1977. Filed date 11 Jun 1975. 8p.

A uranium compound in the solid phase (uranium borohydride four) is subjected to radiation of a first predetermined frequency that excites the uranium-235 isotope-bearing molecules but not the uranium-238 isotope-bearing molecules. The compound is simultaneously subjected to radiation of a second predetermined frequency which causes the excited uranium-235 isotope-bearing molecules to chemically decompose but which does not affect the uranium-238 isotope-bearing molecules. Sufficient heat is then applied to the irradiated compound in the solid phase to vaporize the non-decomposed uranium-238 isotope-bearing molecules but not the decomposed uranium-235 isotope-bearing molecules, thereby physically separating the uranium-235 isotope-bearing molecules from the uranium-238 isotope-bearing molecules. The uranium compound sample in the solid phase is deposited or grown in an elongated tube supported within a dewar vessel having a clear optical path tail section surrounded by a coolant. Two sources of radiation are focused on the uranium compound sample. A heating element is attached to the elongated tube to vaporize the irradiated compound.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 54323

54028 Reactions of uranium oxysulfide with some nonmetals and metals. Komac, M. (Jozef Stefan Inst, Ljubljana, Yugosl). *Sov. Powder Metall. Met. Ceram. (Engl. Transl.);* **15**: No. 10, 811-813(Oct 1976).

Investigations into the synthesis of uranium monosulfide, US--a potential fast breeder reactor fuel, show that this is a complex process which can be successfully carried out only on a laboratory scale; when it is performed on a large scale, the synthesis yields a product contaminated with oxygen, which forms the phase UOS. A study was made, using optical microscopy and x-ray diffraction techniques, of the reactions of uranium oxysulfide with boron, silicon, lanthanum, and yttrium in the temperature range 1000-1700°C. Boron and silicon cannot be employed as reducing agents in the synthesis of uranium monosulfide from uranium oxysulfide. It was established that in the operation of a reactor UOS present in sulfide fuel is a harmful impurity because it reacts with lanthanides forming in the course of fission. 7 refs.

54029 Uranium-base alloys. Ross, A.M. (to Atomic Energy of Canada Limited). US Patent 4,023,992. 17 May 1977. Priority date 28 Jun 1973, Canada. 4p.

Uranium-base alloys suitable as nuclear fuel contain about 3.2 to 3.7 wt % Si, from about 0.8 up to about 3 wt % Al and the balance U; however, when the Al content is not more than 1.5%, the Si content is less than 3.5%. The major phase is delta U_3Si containing about 0.5 wt % of dissolved Al. A method of optimizing the corrosion resistance is also specified.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 54042, 54045, 54051, 54055, 54056, 54057, 54064

54030 (JAERI-M—6664) **Fluorination of uranium oxides in an engineering scale of fluidized bed.** (Japan Atomic Energy Research Inst., Tokyo). Aug 1976. 63p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

In the R and D program for the reprocessing by fluoride volatility process, batch and semi-continuous fluorination have been studied using uranium oxides with or without nonradioactive fission products. A 3 inch-phi fluidized bed was used in obtaining the engineering fluorination date and also handling techniques for kilogram quantities of fluorine and uranium hexafluoride. Described are the equipment system and their technical experiences, mock-up experiments for the determination of fluidization conditions, fluorination rate and F_2 utilization, and developments of in-line gas analyzers such as gas chromatograph and thermal conductivity cell for F_2 and/or UF_6.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 54515

WASTE PROCESSING

REFER ALSO TO CITATION(S) 54065

54031 (CONF-760822—P1) **Proceedings of the fourteenth ERDA air cleaning conference.** First, M.W. (ed.). (Energy Research and Development Administration, Washington, D.C. (USA); Harvard Univ., Boston, Mass. (USA). Harvard Air Cleaning Lab.). 1976. 553p. Dep. NTIS, PC A24/MF A01.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

Individual papers were indexed for inclusion in the ERDA Energy Research Abstracts. (LK)

54032 (CONF-760822—P1, pp 9-16) **Volume reduction of contaminated filter wastes.** Buttedahl, O.I.; Terada, K. (Rockwell International Corp., Golden, CO). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Reported are details of a pilot project to design and construct a compactor to reduce the handling of high efficiency particulate air (HEPA) filters used in air filtration systems at facilities where radioactive materials are processed. In such systems at Rocky Flats Plant, filters require frequent change and removal. Large quantities are used and will be increased for future operations. With the completion of the pilot model, it has been demonstrated that volume reductions of more than 80% can be achieved and cost savings will be realized also.

54033 (CONF-760822—P1, pp 17-50) **Molten salt combustion of radioactive wastes.** Grantham, L.F.; McKenzie, D.E.; Richards, W.L.; Oldenkamp, R.D. (Rockwell International Corp., Canoga Park, CA). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The Atomics International Molten Salt Combustion Process reduces the weight and volume of combustible β-γ contaminated transuranic waste by utilizing air in a molten salt medium to combust organic materials, to trap particulates, and to react chemically with any acidic gases produced during combustion. Typically, incomplete combustion products such as hydrocarbons and carbon monoxide are below detection limits (i.e., <30 ppM and $<0.05\%$, respectively). Hydrogen chloride in the off-gas, when pure polyvinyl chloride is burned, is also below detection limits (<5 ppM). Particulate concentration in the off-gas (typically 0.2 mg/m^3) is directly related to the sodium chloride vapor pressure of the melt; $<80\%$ of the particulate is sodium chloride. Essentially all metal oxides (combustion ash) are retained in the melt, e.g., $<99.9\%$ of the plutonium, $<99.6\%$ of the europium, and $<99.9\%$ of the ruthenium are retained in the melt. Both bench-scale radioactive and pilot scale (50 kg/hr) nonradioactive combustion tests have been completed with essentially the same results. Design of three combustors for industrial applications are underway.

54034 (CONF-760822—P1, pp 51-69) **Incinerator for power reactor low-level radioactive waste.** Drolet, T.S.; Sovka, J.A. (Ontario Hydro, Toronto). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The technique chosen for volume reduction of combustible waste is incineration by a propane-fired unit. Noncombustible material will be compacted into 200 liter drums. A program of segregation of wastes at the producing nuclear stations was instituted. The design and operation of the incinerator, dose limits to the public, and derived release limits for airborne effluents are discussed.

54035 (CONF-760822—P1, pp 70-79) **Fluidized bed incinerator development.** Ziegler, D.L.; Johnson, A.J. (Rockwell International Corp., Golden, CO). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

A fluidized bed incinerator is being developed for burning rad contaminated solid and liquid waste materials. In situ neutralization of acid gases by the bed material, catalytic afterburning, and gas filtration are used to produce a clean flue gas without the use of aqueous scrubbing.

54036 (CONF-760822—P1, pp 80-101) **Particulate collection in a low level radioactive waste incinerator.** Rudnick, S.N.; Leith, D.; First, M.W. (Harvard Air Cleaning Lab., Boston). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

As designed, sintered stainless steel filters will clean the gas from the secondary cyclone at a low level radioactive waste incinerator. Using bench scale apparatus, asbestos floats and diatomaceous earth were evaluated as filter aids to prevent clogging of the sintered metal interstices and to decrease filter penetration. Both precoats prevented irreversible pressure drop increase, and decreased cold DOP penetration from 80% to less than 1%. To collect the same quantity of fly ash, less diatomaceous earth was needed than asbestos floats. A back-up study evaluated a moving bed of sodium carbonate pellets in lieu of the sintered metal filters. Since identical sodium carbonate pellets are used to neutralize hydrogen chloride in the incinerator, their use in a moving bed has the advantages of trouble free disposal and cost free replacement. Co, counter, and cross-current beds were studied and gave fly ash penetrations less than 0.1% at moderate pressure drop.

54037 (CONF-760822—P1, pp 233-250) **Dependence of gas penetration of charcoal beds on residence time and linear velocity.** Deitz, V.R. (Naval Research Lab., Washington, D.C.); Blachly, C.H.; Jonas, L.A. 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The trapping of methylradioiodide (CH_3I^{131}) was studied in packed columns of different diameters, bed depths, and at various flow velocities, using impregnated granular activated charcoals. The gradient in penetration along the axis of flow was determined after dividing the column into eight equal layers by discs of perforated stainless steel, followed by a back-up section, and counting each layer. In one series of measurements six columns were used in which the depth and the corresponding superficial linear velocity was varied 5.6 fold; the weight and volume of charcoal and the volumetric flow rate were held constant. Although the residence time was constant (0.25 sec) in all six columns, significant decreases in penetration occurred with increase in linear velocity. In other series of measurements, the diameter, depth, and weight of charcoal were held constant and the volumetric flow rate was varied over a wide range of superficial linear velocity. Differences in penetrability, as a result of varying the bed geometry, the residence time, and the flow velocity were examined in accord with recent concepts of adsorption kinetics and catalytic behavior in packed beds.

54038 (CONF-760822—P1, pp 266-286) **Method for correlating weathering data on adsorbents used for the removal of CH_3I.** Parish, H.C.; Muhlenhaupt, R.C. (CVI Corp., Columbus, OH). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Traditionally, weathering data have been expressed in terms of removal efficiency as a function of time for a select number of bed depths. Variables include: (1) variations in the efficiency of the adsorbent when new; (2) guard bed design (bed depth, replacement schedule); (3) air quality; and (4) air velocity. This paper discusses the development of a single parameter, namely, the Effective Weathering Rate (EWR), its usefulness in correlating weathering data, and subsequent utilization during design. The effectiveness of the model was checked by analyzing several sets of data. Values of EWR were determined from the limited available experimental data for air which could be described only qualitatively as ranging from relatively clean to relatively dirty air from a heavily industrialized area. As quantitative data become available, it is expected that the EWR can be correlated with the character and concentration of air contaminants such as hydrocarbons, SO_2, NO/sub x/ and O_3. The EWR, determined from experimental data, can be used to predict adsorber efficiencies for conditions corresponding to a specific application. Some of the changes in conditions which can be treated by this method include: (1) bed depth of adsorbent, (2) addition of guard bed or depth of guard bed, (3) effectiveness of the carbon (new), (4) operating time, and (5) air velocity. Someparametric studies were performed analytically to demonstrate some applications of the weathering model. These included calculating the adsorber efficiency as a function of time and bed depth, for carbons having various efficiencies when new, and for guard beds of variable bed depth and having different replacement schedules for the guard bed material.

54039 (CONF-760822—P1, pp 287-293) **Iodine removal adsorbent histories, aging and regeneration.** Hunt, J.R.; Rankovic, L.; Lubbers, R.; Kovach, J.L. (Nuclear Consulting Services Inc., Columbus, OH). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The experience of efficiency changes with life under various test conditions is described. The adsorbents were periodically removed from both standby and continuously operating systems and tested under various test methods for residual iodine adsorption efficiency. Adsorbent from several conventional "sampler" cartridges versus the bulk adsorbent was also tested showing deficiency in the use of cartridge type sampling. Currently required test conditions were found inadequate to follow the aging of the adsorbent because pre-equilibration of the sample acts as a regenerant and the sample is not tested in the "as is" condition. The most stringent test was found to be the ambient temperature, high humidity test to follow the aging of the adsorbent. Several methods were evaluated to regenerate used adsorbents; of these high temperature steaming and partial reimpregnation were found to produce adsorbents with near identical properties of freshly prepared adsorbents.

54040 (CONF-760822—P1, pp 294-309) **New charcoal impregnants for trapping methyl iodide I. Salts of the iodine oxyacids with iodide or iodine and hexamethylenetetraamine.** Deitz, V.R.; Blachly, C.H. (Naval Reseach Lab., Washington, DC). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Iodine in its various chemical compounds can have the oxidation states I^-, I^0, I^{+1}, I^{+5} and I^{+7}. When alkali salts of the iodine oxyacids (KIO, KIO_3 and KIO_4) are mixed with iodides (I^-) and/or elementary iodine in basic solution, the mixtures containing the extremes in valence states are converted into compounds of intermediate charge. A number of charcoals were impregnated with selected mixtures and these proved to be excellent trappers for methylradioiodide. Hexamethylenetetraamine (HMTA), a tertiary amine having a high flash point and low volatility, was also included in the impregnations investigated as a second impregnate. About two hundred samples were impregnated with the iodine mixtures and HMTA using the 2-stage process on a variety of base charcoals and these were evaluated for methyliodide trapping and ignition behavior. Some of the promising impregnated charcoals were also evaluated in other laboratories. The results are presented and a fundamental interpretation proposed for the trapping mechanism based upon a dissociation-controlled exchange (the exchange controlled by dissociation of one of the species) via a simple effective chain reaction.

54041 (CONF-760822—P1, pp 353-362) **Remarks on testing the reliability of iodine adsorption in ion-exchanging charcoal-filters with respect to solvent loadings.** Strauss, H.J.; Winter, K. (Ceagfilter und Entstaubungstechnik GmbH, Dortmund, Germany). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The reliability of high-efficient removal of fission iodine and its compounds depends on the condition of iodide-impregnated charcoal, especially on foreign loads, e.g., solvents. Samples of the charcoal taken from monitor-filters will have an equivalent load if flow-velocity is equal to that in the iodine-filter. But, the influence of geometric form and of bulk density is not to be neglected, insofar as conditions for identic flow-velocity cannot be assumed. It seems, that a good sample only can be taken directly out of the charcoal by pipette. Foreign loads below about 3% have practically no influence on the reliability of high-efficient-iodine-removal. When operating a charcoal-filter at temperatures in the range of 70°C to 90°C the equilibrium of adsorption of solvents is below this level with respect to the concentrations occurring in practice. Further advantages are: The relative humidity is lowered and the humidity of the carbon is lowered. Therefore the iodine-removal can be kept to a high efficiency.

54042 (CONF-760822—P1, pp 363-380) **Airborne elemental iodine loading capacities of metal zeolites and a dry method for recycling silver zeolite.** Staples, B.A.; Murphy, L.P.; Thomas, T.R. (Idaho National Engineering Lab., Idaho Falls). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Several metal-exchanged zeolites have been tested to determine their elemental-iodine-loading capacities at breakthrough in air streams. The experiments were directed toward the application of the adsorbents for the removal of iodine-129 from the process off-gas of nuclear fuel reprocessing plants. The effects of the bed temperature, face velocity, bed depth, water vapor, and NO_2 on the loading capacities were examined. Only silver-exchanged zeolite was found to have a high chemisorption capacity for elemental iodine both in dynamic and static loading tests. The chemisorption capacities of lead-, cadmium-, and silver-exchanged zeolites for iodine are discussed in terms of thermodynamics. Experiments were conducted to develop a method for recycling silver-exchanged zeolite. Iodine-desorption tests were performed by purging iodine-loaded silver-exchanged zeolite with pure hydrogen at bed temperatures of 400 to 700°C. The predicted rates of hydrogen iodide removal from silver iodide based on thermodynamic calculations are compared to the rates of removal observed from silver iodide dispersed in a zeolite matrix. The characteristics of test beds which were regenerated and reloaded several times are described. The use of lead-exchanged zeolite as an adsorbent for the hydrogen iodide purged from the silver-exchanged zeolite was studied. The potential application of silver-exchanged zeolite as a primary adsorbent for radioiodine removal from process off-gas and lead-exchanged zeolite as a secondary adsorbent for storage is evaluated.

54043 (CONF-760822—P1, pp 381-388) **Air filtration plants of wall-type for separation of fission iodine in nuclear reactors.** Stiehl, H.H.; Neumann, M.; Sinhuber, D. (Delbag-Luftfilter GmbH, Berlin). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The increasing density of nuclear power stations and increased safety requirements will lead in future to higher flow rates and longer residence times in the adsorption filter layer of the iodine sorption filter plants of nuclear power stations. The safety requirements in the Federal Republic of Germany have been complied with so far in the conventional way by means of duct-type filter construc-

tions. For the higher flow rates and longer residence times necessary in future, we propose a filter construction of wall-type, which complies with the safety regulations of the Federal Republic of Germany. The economic and technical advantages are discussed.

54044 (CONF-760822—P1, pp 389-431) **Airborne radioiodine species sampler and it's application for measuring removal efficiencies of large charcoal adsorbers for ventilation exhaust air.** Emel, D. (Allied Chemical Corp., Idaho Falls, ID); Hetzer, D.; Pelletier, C.A.; Barefoot, E.D.; Cline, J.E. 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

A program, sponsored by the Electric Power Research Institute, is underway to determine the chemical species of radioiodine coming from LWR power plants and their persistence in the nearby environment. In support of this program, an airborne radioiodine sampler, developed and used by the AEC was modified and tested. This sampler consists of five components. The components are: (1) a particulate filter, (2) CdI_2 on a matrix of chromosorb-P to retain I_2, (3) 4-Iodophenol on a matrix of activated alumina to retain HOI, (4) silver exchanged molecular sieve-13X to retain organic iodides, and (5) impregnated charcoal to serve as a control. The AEC sampler has not been proof-tested for periods over 48 hours or for flow rates above 0.10 l/s. For maximum sensitivity, a sampler is required to be used for periods of one to two weeks and at a flow rate giving a bed residence time of 0.1 sec. The AEC sampler was scaled up in size to attain an air sampling rate of 0.9 l/s. Each media for this sampler (except the particulate filter) was tested in the laboratory for retention of the iodine species; I_2, Organic, and HOI. The tests were conducted at typical conditions observed at the main iodine release points at nuclear power plants. Confirmatory tests were run at operating nuclear power plants. The test results showed that under normal plant conditions the sampler could be operated at flow rates up to 0.80 l/s and differentiate the iodine species I_2, HOI, and CH_3I. The retention efficiencies of each media for its specie of radioiodine were found to be: I_2 on CdI_2 - 87 +- 5%, HOI on IPH 94 +- 4%, and CH_3I on Ag 13-X or KI charcoal 99 +- 1%.

54045 (CONF-760822—P1, pp 447-488) **Head-end iodine removal from a reprocessing plant with a solid sorbent.** Wilhelm, J.G. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Germany); Furrer, J.; Schultes, E. 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

In the first large-scale reprocessing plant planned in the Federal Republic of Germany a total amount of 580 kg of iodine per annum will be released in the fuel dissolution process for a maximum heavy metal throughput of 1800 tons per year and 40,000 MWd/t of burnup. The main portion of the iodine is formed by the ^{129}I (T/sub 1/2/ = 1.6 x 10^7 a) isotope of which 82 Ci at the maximum are released every year. With the scheduled fuel element storage time of greater than or equal to 220 d the simultaneous release of ^{131}I is less than or equal to 12.5 Ci the mass of which does not play any part. According to the computer model presently imposed in the Federal Republic of Germany for treatment of the environmental impact by radioiodine, a total decontamination factor of 340 must be attained. This implies a long-term diffusion factor of 1 x 10^{-7} s/m^3 for releases via the stack of the reprocessing plant and a limit value of 50 mrem/a at the maximum for the thyroid dose to the critical group of the population via the ingestion path. The flowsheet for dissolver off-gas cleaning in a reprocessing plant employing solid iodine sorption material and the arrangement of filter components are discussed. The principle of an iodine sorption filter is described which allows exhaustive loading of the iodine sorption material. The removal reactions of different organic iodine compounds and the loading capacity and removal efficiency of the iodine sorption material in the original dissolver off-gases of reprocessing plants are indicated. Studies on the influence of filter poisons are reported.Operating experience gathered with a first iodine sorption filter in operation is discussed; this filter has been used to remove practically all iodine produced in the dissolver off-gas of the Karlsruhe Reprocessing Pilot Plant (WAK). Direct measurement of ^{129}I in samples of filter material using a low energy photon spectrometer is briefly reported.

54046 (CONF-760822—P1, pp 490-506) **Selective sampling of hypoiodous acid.** Kabat, M.J. (Ontario Hydro, Pickering, Canada). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

A new material has been developed which efficiently separates hypoiodous acid from a mixture of penetrative species of airborne radioiodine. This selective absorbent has high absorption and retention efficiency for hypoiodous acid under conditions of high relative humidity and short residence time for an extended sampling period. Very low absorption of methyliodide in this absorbent has been measured under the same conditions. A sampler, components of which selectively absorb particulate iodine, elemental iodine, hypoiodous acid and organic iodides, has been assembled and successfully applied for airborne radioiodine sampling in an operational field. The method and equipment used for laboratory testing of the HOI absorbent and for field sampling of iodine species are described herein. Experimental results are also presented and discussed.

54047 (CONF-760822—P2) **Proceedings of the fourteenth ERDA air cleaning conference.** First, M.W. (ed.). (Energy Research and Development Administration, Washington, D.C. (USA); Harvard Univ., Boston, Mass. (USA). Harvard Air Cleaning Lab.). 1976. 623p. Dep. NTIS, PC A99/MF A01.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

Individual papers were indexed for inclusion in ERDA Energy Research abstracts. (LK)

54048 (CONF-760822—P2, pp 677-693) **Exhaust filtration on gloveboxes used for aqueous processing of plutonium.** Woodard, R.W.; Grossaint, K.J.; McFeeters, T.L. (Rockwell International Corp., Golden, CO). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The report covers information obtained during the study of ventilation of glovebox systems used for wet process operations associated with plutonium recovery. Analytical data are presented on: concentration of chemical components in exhaust air, concentration of radioactive material, and chemical species deposited on, or found in, HEPA filters in the exhaust systems.

54049 (CONF-760822—P2, pp 836-841) **Effect of exposure times in the prehumidification of impregnated charcoals.** Deitz, V.R.; Blachly, C.H. (Naval Research Lab., Washington, DC). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

An integral step in the test procedure for determining the trapping efficiency of methyliodide at 25°C is the prehumidification of the impregnated charcoal. The specifications (1) direct that the prehumidification with air at 95 +- 2% RH be continued until the temperatures recorded at the entrance and exit of the charcoal bed are equal. Since this operation may require about five hours, it is convenient to allow the prehumidification to extent overnight (sixteen hours). This Note is concerned with the unexpected adverse influence on methyliodide trapping by exposures of charcoals to prehumidification at long contact times.

54050 (CONF-760822—P2, pp 844-869) **Iodine emission during a programmed heating of impregnated charcoals in carrier air.** Deitz, V.R.; Romans, J.B. (Naval Research Lab., Washington, DC). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

In the thermal analysis of some impregnated charcoals there are present chemical reactions that form volatile organic iodides at temperatures lower than ignition, thus raising the possibility of iodine release. The magnitudes of the spontaneous ignition temperature (SIT) of nuclear grade charcoals appear to be of secondary importance. The impregnations on charcoals of the oxyiodide-HMTA formulation are of greater stability than the present KI/sub x/ impregnations. The total iodine emission integrated to a specified temperature (e.g. 180°C) is a small fraction (~ 10^{-6}) of the total iodine in the impregnation; the emission varies somewhat with both charcoal and impregnation formulation for a specified temperature. The experimental procedure is now being applied to follow the iodine emission at constant temperatures for time periods up to 24 hours. These results will complement the desorption tests at 180°C already reported by A.G. Evans (DP 1280, Savannah River Laboratory).

54051 (CONF-760822—P2, pp 870-877) **Containment and recovery system for fuel-reprocessing plants.** Galloway, T.R. (Univ. of California, Livermore). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

We identify tritium containment and removal problems in a fuel-reprocessing plant and explore conceptual process designs for reducing emissions to the environment to below 1 Ci/day. The conceptual design recommended would allow an air atmosphere in

the reprocessing-plant hall, and would use a continuous-catalytic-oxidizer/molecular-sieve-adsorber cleanup system to maintain a 40-$\mu Ci/m^3$ tritium level (5 $\mu Ci/m^3$ HTO) against 180 Ci/day leakage from components and process piping.

54052 (CONF-760822—P2, pp 878-883) **Reducing air cleanup system costs.** Reedquist, H.R. Jr. (CTI-NUCLEAR, Inc., Denver). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The majority of Air Cleanup System specifications issued this last year, for Air Cleanup System manufacturers to bid to, have contained numerous errors. This increases the engineers time and manufacturers time and costs in resolving and correcting these errors, thus frequently delaying the schedule and increasing the Air Cleanup Systems cost. Accurate specifications reduce cost.

54053 (CONF-760822—P2, pp 947-956) **Delay of xenon on charcoal beds.** Collard, G.; Put, M.; Broothaerts, J.; Goossens, W.R.A. (CEN, Mol, Belgium). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The dynamical adsorption of Xenon on a fixed bed of charcoal type RBL-3 has been investigated in a 15-cm-diameter column by applying a ^{133}Xe pulse. The experimental break-through curves were fitted by the Gaussian relationships proposed by Underhill. All data are summarized by a Van Deemter's equation the parameter values of which have been determined by non-linear regression analysis of the results.

54054 (CONF-760822—P2, pp 964-1001) **Development of the cryogenic selective adsorption-desorption process on removal of radioactive noble gases.** Kanazawa, T. (Kobe Steel, Ltd., Japan); Soya, M.; Tanabe, H.; An, B.; Yuasa, Y.; Ohta, M.; Watanabe, A.; Nagao, H.; Tani, A.; Miharada, H. 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Cryogenic selective adsorption-desorption process was developed as an effective means of removing the radioactive noble gases. A series of experiments and evaluation studies have been performed to develop a new type off gas clean up system which adopted the above process to remove the noble gases from the off gas streams of nuclear facilities. The fundamental processes of our proposed clean up system are as follows: (1) noble gas enrichment process to remove and enrich the radioactive noble gases from off gas, (2) oxygen removal process to remove oxygen and oxide impurities from enriched gas, and (3) storage process to store enriched gas into cylinder. For the first process, the "selective adsorption-desorption"method was adopted. The laboratory scale experiments were performed to investigate the breakthrough and enrichment. And the engineering scale experiments are being carried out to confirm them. For the second process, "metal getter absorption" method has been developed. The static experiments were performed with heated zirconium metal getter. And the dynamic experimental apparatus is constructed and will be operated. For the third process, "adsorbent packed cylinder" method has been developed. From the laboratory experiment, it has been proved to have several advantages. This investigation showed that the proposed methods could be applied to the off-gas clean up system of the nuclear facilities.

54055 (CONF-760822—P2, pp 1002-1016) **Separation of the fission product noble gases krypton and xenon from dissolver off-gas in reprocessing HTGR-fuel.** Bohnenstingl, J.; Djoa, S.H.; Laser, M.; Mastera, S.; Merz, E.; Morschl, P. (Kernforschungsanlage Juelich GmbH, Germany). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

This paper describes a process developed for the retainment and separation of volatile (^3H, $^{129+131}I$) and gaseous (^{85}Kr, Xe) fission products from the off-gas produced during dissolution of HTGR-fuel. To prevent unnecessary dilution of liberated noble gases by surrounding atmosphere, a helium purge-gas cycle is applied to enable a coarse fractionating of krypton and xenon by cold-trapping at about 80°K after precleaning the gas stream. The process consists of the following steps: deposition of droplets and solid aerosols; chemisorption of iodine on silver impregnated silica gel; catalytic removal of nitrogen oxides and oxygen; drying of the process gas stream; final filtering of abraded solids; deposition of xenon in solid form at 80°K and low subpressure; deposition of krypton in solid form at 80°K after compression to about 6 bar; decontamination of ^{85}Kr-containing xenon by batch distillation for eventual industrial utilization; and removal of nitrogen and argon enrichment during continuous operation in the purge-gas stream by inleaking air with charcoal. A continuously operating dissolver vessel, closed to the surrounding atmosphere, yields a very high content of noble gases, i.e., 0.35 vol % krypton and 2.0 vol % xenon. The presented off-gas treatment unit is operated in cold runs with 1/3 of the full capacity and can treat about 1 m^3 STP/h helium, corresponding to a quantity of about 10,000 MW/sub e/ HTGR-fuel reprocessing plant.

54056 (CONF-760822—P2, pp 1017-1033) **Development of the FASTER process for removing krypton-85, carbon-14, and other contaminants from the off-gas of fuel reprocessing plants.** Stephenson, M.J.; Eby, R.S. (Union Carbide Corp., Oak Ridge, TN). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The Oak Ridge Gaseous Diffusion Plant has the primary responsibility for the development of the FASTER (Fluorocarbon Absorption System for Treating Effluents from Reprocessors) process for application to LMFBR and LWR fuel reprocessing plants. Krypton-85 removals in excess of 99.9% and carbon-14 as carbon dioxide removals greater than 99.99% have been obtained in a development pilot plant. So far, pilot plant tests show that the presence of other reprocessing plant off-gas components does not appreciably affect the general operability or removal efficiency of the process. Tests also indicate that the one process designed for krypton and carbon removal may be even more effective in removing other fission products and objectionable chemical contaminants such as nitrogen dioxide. Elemental and organic iodine removals in excess of 99.99% and nitrogen dioxide removals over 99% were recently achieved. Higher process decontaminations are possible. Trapping studies show that 13X molecular sieves are very effective in removing the fluorocarbon vapor from the process product stream.

54057 (CONF-760822—P2, pp 1034-1043) **HTGR-reprocessing off-gas cleaning by the AKUT-process.** Barnert-Wiemer, H.; Beaujean, H.; Laser, M.; Merz, E.; Vygen, H. (Kernforschungsanlage Juelich GmbH, Germany). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

During reprocessing of HTGR-fuel the graphite matrix has to be removed in order to gain the heavy metal, which is accomplished by burning the crushed fuel elements. During the burning part of the krypton and tritium is released from the fuel. Since the combustion gas is a mixture of CO_2 and O_2, the burner off-gas consists mainly of CO_2 with a small amount of CO and fission products, mainly in gaseous form but also aerosols. A facility, called AKUT II, which consists of the following process steps: aerosol removal by electrostatic precipitators followed by HEPA-filters, catalytic conversion of CO and O_2 to CO_2, compression and liquefaction, separation of krypton by distillation, and adsorption of tritiated water on molecular sieve is now being installed in the KFA hot cells. The facility will be ready for cold operation early in 1977. After start-up of the HTGR-reprocessing pilot plant JUPITER the off-gas from the head-end will be treated in the AKUT facility.

54058 (CONF-760822—P2, pp 1065-1075) **Experimental determination of reaction rates of water: hydrogen exchange of tritium with hydrophobic catalysts.** Bixel, J.C.; Hartzell, B.W.; Park, W.K. (Monsanto Research Corp., Miamisburg, OH). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

This study was undertaken to obtain data needed for further development of a process for the enrichment and removal of tritium from the water associated with light-water reactors, fuel-reprocessing plants, and tritium-handling laboratories. The approach is based on the use of antiwetting, hydrophobic catalysts which permit the chemical exchange reactions between liquid water and gaseous hydrogen in direct contact, thus eliminating problems of catalyst deactivation and the complexity of reactor design normally associated with current catalytic-detritiation techniques involving gas-phase catalysis. An apparatus and procedure were developed for measuring reaction rates of water-hydrogen chemical exchange with hydrophobic catalysts. Preliminary economic evaluations of the process were made as it might apply to the AGNS fuel reprocessing plant.

54059 **Tank depletion flow instruments.** Georgeson, M.A. (Allied Chem Corp, Idaho Falls, Idaho). *Adv. Instrum.;* 31: 1-8(1976).

A new flowmetering system is developed to measure and control flow without the need for an inline flowmeter. Flowrate is determined from the rate of level change in reference vessel. This system is unique in its use of balance pots for zero suppression to

enable range amplification. The result is an accuracy in flow measurement and control as good as +-1%. The system uses state-of-the-art digital integrated circuits with a crystal time base in conjunction with the time-proven pneumatic bubbler probe low range transmitters. The benefits are (1) reduced radiation exposure to personnel during maintenance of flowmeters for radioactive streams since instruments are all located in an operating area isolated from the process by four feet of concrete, (2) reduced volume of solid nuclear wastes through processing efficiencies, (3) reduced cost of chemicals involved, (4) increased speed of flowrate determination, (5) reduced maintenance time and material cost to correct flow instrument component failures, (6) no obstruction to flow in the process stream, and (7) reduced cost of instrumentation to determine flowrate. A disadvantage is the requirement that flow must be related to tank level thus only one unknown flow into or out of a given vessel at a time may be metered and controlled. 1 ref.

54060 Solid forms for Savannah River Plant radioactive wastes. Wallace, R.M.; Hale, W.H.; Bradley, R.F.; Hull, H.L.; Kelley, J.A.; Stone, J.A.; Thompson, G.H. (E. I. du Pont de Nemours and Co., Inc., Aiken, SC). *Adv. Chem. Ser.;* No. 153, 9-30(1976).

Methods are being developed to immobilize Savannah River Plant wastes in solid forms such as cement, asphalt, or glass. ^{137}Cs and ^{90}Sr are the major biological hazards and heat producers in the alkaline wastes produced at SRP. In the conceptual process being studied, ^{137}Cs removed from alkaline supernates, together with insoluble sludges that contain ^{90}Sr, will be incorporated into solid forms of high integrity and low volume suitable for storage in a retrievable surface storage facility for about 100 years, and for eventual shipment to an off-site repository. Mineralization of ^{137}Cs, or its fixation on zeolite prior to incorporation into solid forms, is also being studied. Economic analyses to reduce costs and fault-tree analyses to minimize risks are being conducted. Methods are being studied for removal of sludge from (and final decontamination of) waste tanks.

54061 Putting evaporators to work: concentration of aqueous radioactive waste. Goodlett, C.B. (Du Pont Co., Aiken, SC). *Chem. Eng. Prog.;* 63-64(Apr 1976).

Tests showed that wiped-film evaporators can concentrate Purex aqueous radioactive waste to a product that solidifies at room temperature. Two other types of aqueous nuclear wastes, HM waste and decladding waste, can be similarly concentrated. Two experimental designs were evaluated, a horizontal and a vertical wiped film evaporator. A free-flowing product was obtained with less than 20 wt percent water (total). Two prototype vertical wiped film evaporators with 40 ft^2 heat transfer surface were designed with anticipated feed capacity of 1 million gal/y of alkaline Purex solution containing 30 wt percent solids. (DLC)

54062 Results of the survey on radioactive wastes in RI utilization. *Genshiryoku Iinkai Geppo;* **21**: No. 4, 9-16(Jun 1976). (In Japanese).

With expansion in the usage of radioisotopes in recent years, the radioactive wastes from the enterprises using unsealed RIs are on the increase, and their treatment and disposal are now major problems. The wastes are stored temporarily on the sites of the enterprises, or treated collectively and stored in Japan Atomic Energy Research Institute. The results of the survey on radioactive wastes from 996 locations of enterprises (including radioactive medical compounds, but excluding nuclear materials) are summarized as follows: the quantities of RIs consumed in fiscal 1974; the amounts of radioactive wastes generated in fiscal 1974, the stored quantities of radioactive wastes as of October 1, 1975, and the quantities of radioactive wastes expected in fiscal 1980; pretreatment of radioactive wastes at the enterprises, and consignees of radioactive wastes.

54063 Some experience on construction and test operation of the very low level radioactive liquid waste evaporator. Muramatsu, T.; Ishikawa, T.; Yamagishi, Y.; Fukushima, Y. (Ebara Mfg. Co. Ltd., Tokyo (Japan)). *Ebara Jiho;* No. 97, 31-35(Sep 1976). (In Japanese).

An autovaper evaporation system has been designed and constructed for further decontamination of distillates from low and medium level waste concentrators of the fuel reprocessing facility before sea disposal of the treated waste. The system distills the effluents from the above systems in a natural vertical circulation type evaporator with capacity of 4.5 m^3/h manufactured of special low carbon stainless steel under severe quality control. The system has shown good performances in the cold test operation compared with the predicted capabilities including a newly developed and designed steam compressor for saving primary heating steam.

54064 Electrolytic trapping of iodine from process gas streams. Horner, D.E.; Mailen, J.C.; Posey, F.A. (to Energy Research and Development Administration). US Patent 4,004,993. 25 Jan 1977. Filed date 26 Feb 1976. 8p.

PAT-APPL-661,571.

A method for removing molecular, inorganic, and organic forms of iodine from process gas streams comprises the electrolytic oxidation of iodine in the presence of cobalt-III ions. The gas stream is passed through the anode compartment of a partitioned electrolytic cell having a nitric acid anolyte containing a catalytic amount of cobalt to cause the oxidation of effluent iodine species to aqueous soluble species.

WASTE DISPOSAL AND STORAGE

54065 (CONF-760822—P1, pp 118-132) ^{85}Kr storage by zeolite encapsulation. Brown, R.A.; Hoza, M.; Knecht, D.A. (Idaho National Engineering Lab., Idaho Falls). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The technology of ^{85}Kr storage by zeolite encapsulation is described. The process of encapsulation takes place at high temperatures and pressures, and involves the activated diffusion of krypton into zeolite cages. Experimental results for krypton encapsulation in various zeolites are reviewed and discussed. Activated diffusion parameters determined by measuring krypton leakage rates from zeolites at high temperatures and low pressures are used to estimate leakage rates of ^{85}Kr during long-term storage. The potential safety benefits are determined for krypton-85 storage by encapsulation in sodalite. Requirements for pilot-scale and process-scale development are discussed briefly.

54066 Radioactive waste. Gauvenet, M. (GOmmis a l'Energie At, Fr). *Rev. Energ.;* **28**: No. 290, 7-14(Jan 1977). (In French).

After a review of the radioactive waste materials and problems of their disposal in the short and long term, the conclusion is reached that radioactive substances are not a threat. Our Earth is itself radioactive and so are our bodies. It is consequently a question of degree.

54067 Soviet answer to nuclear waste. Belitzky, B. *New Sci.;* **74**: No. 1048, 128-129(21 Apr 1977).

The problem of radioactive waste disposal in the Soviet Union is discussed. Selection of burial sites includes thorough hydrogeological surveying of the region as was done in the case of Dimitrovgrad where 32 000 curies of low and medium level activity in 775 000 cubic meters of liquid were pumped into three boreholes during the period April 1966 to October 1975. It is considered that this technique has substantial economic advantages over the evaporation method. For high-level wastes Soviet experts regard vitrification as the most reliable though expensive method. Methods involving cementation, bituminization and fixation in ceramics or asphalt are being investigated. It is felt that the problems of radioactive waste disposal are an area in which such countries as the Soviet Union and Britain with their respective highly advanced nuclear power industries, could cooperate to mutual advantage.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 54031, 54037, 54038, 54039, 54040, 54041, 54042, 54043, 54044, 54045, 54047, 54051, 54053, 54054, 54055, 54056, 54057, 54058, 54066

54068 Newsletter on the Fox Report. Ranger uranium environmental inquiry. First report Australian Government Publishing Service, Canberra 1976. *J. Br. Nucl. Energy Soc.;* **16**: No. 2, 101-102(Apr 1977).

In July 1975 the Australian Government ordered an inquiry into the proposed development of uranium deposits in the Ranger area of the Northern Territories, setting up a three-man Commission with Sir Justice Russel Walter Fox presiding. The first report of the Ranger Uranium Environmental Inquiry, generally known as the Fox Report, was recently published. In addition to environmental pollution problems the Commission also considered uranium demand, possibility of diversion of material, and risks of theft and sabotage. The principal findings and recommendations of the report are presented. The final recommendation lists what it is considered should be the objectives of the controls and regulations for Australian uranium mines.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 54011

54069 Rationale for EPA's proposed uranium fuel cycle standards. Giardina, P.A. pp 452-457 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

The proposed Environmental Protection Agency radiation standards for normal operations of the uranium fuel cycle are intended to achieve two principal objectives: (1) to assure protection of members of the public against radiation doses resulting from fuel cycle operations, and (2) to limit the environmental burden of long-lived radioactive matrials that may accumulate as a result of the production of electrical energy, so as to limit their long-term impact on both current and future populations. These objectives are proposed to be achieved by standards which would limit: (1) annual dose equivalent to the whole body or any internal organ, except the thyroid, to 25 millirems, and the annual dose equivalent to the thyroid to 75 millirems; and (2) the quantities of krypton-85, iodine-129, and plutonium and other alpha-emitting transuranic elements with half lives greater than one year released to the environment per gigawatt-year of power produced by the entire fuel cycle to 50,000 curies, 5 millicuries, and 0.5 millicuries, respectively. EPA believes these proposed standards fulfill the objective of insuring the maximum radiation impact will be extremely small to any individual from U.S. nuclear power production operations and will insure that an unnecessary legacy of exposures of future generations from nuclear power production is avoided. They will establish environmentally acceptable levels for all future operation of the uranium fuel cycle based upon the use of cost effective controls, and should result in a much needed stabilization of environmental requirements for the entire industry.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 54339

54070 (LA—6820-MS) **LASL upgraded alarm system functional requirements.** Hartway, B.L.; Shaskey, E.N. (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1977. Contract W-7405-ENG-36. 21p. Dep. NTIS, PC A02/MF A01.

This document defines and describes the functional requirements to successfully provide Los Alamos Scientific Laboratory with a combined security and fire alarm system that will satisfy the operational needs of various users and provide compliance with applicable codes and Energy Research and Development Administration security and fire protection requirements. The four major subsystems of the upgraded Laboratory alarm system are field installation, data communications, central station, and remote operation station. Each field installation includes all of the intrusion detection sensors, fire alarm sensors, and all other sensors and controls directly connected to a remote terminal unit at each alarm protected area within the Laboratory complex. The data communications system provides multiplexed data between the remote terminal units and the central station computer, and between the central station computer and the remote display and control equipment for the fire and security response forces. The central station computer automatically processes, displays, and records the status, actions, and events of all alarm system equipment and response force personnel. Finally, the remote operating stations for both fire and security forces provide the following key features: real-time displays, hard copy printouts, keyboard access and control, microfiche-projector drawings and documentation, and data base interaction with displays of all equipment status changes and events occurring with the Laboratory alarm system.

54071 (LA-UR—77-1306) **Conceptual design of integrated safeguards systems.** Shipley, J.P. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 15p. (CONF-770656—15). Dep. NTIS, PC A02/MF A01.

From Annual meeting of the Institute of Nuclear Materials Management; Washington, District of Columbia, United States of America (USA) (29 Jun 1977).

The Los Alamos Scientific Laboratory (LASL) is currently involved in the conceptual design of safeguards for generic facilities in the back-end of the nuclear fuel cycle (spent-fuel reprocessing, plutonium nitrate-to-oxide conversion, mixed-oxide fuel fabrication, plutonium scrap recovery, and waste handling). These studies are first steps aimed at eventually providing detailed designs of integrated safeguards systems to guide safeguards-related facility construction and/or modification. The purpose of this presentation is to describe the conceptual design process in terms of its definition, a systematic procedure for its implementation, some of the tools required, and an example of the results of a conceptual design. The value of conceptual design and its relationship to other facets of the complete facility design process are also discussed.

54072 (SAND—77-0996C) **Perimeter intrusion detection and assessment system.** Eaton, M.J.; Jacobs, J.; McGovern, D.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 30p. (CONF-770656—10). Dep. NTIS, PC A03/MF A01.

From Annual meeting of the Institute of Nuclear Materials Management; Washington, District of Columbia, United States of America (USA) (29 Jun 1977).

The key elements of the system considered at a materials storage site are intrusion sensors, alarm assessment, and system control and display. Three papers discussing each of these topics are compiled. They are abstracted individually. (JSR)

54073 (SAND—77-0996C, pp 8p, Paper A) **Perimeter intrusion sensors.** Eaton, M.J. 1977.

In Perimeter intrusion detection and assessment system.

To obtain an effective perimeter intrusion detection system requires careful sensor selection, procurement, and installation. The selection process involves a thorough understanding of the unique site features and how these features affect the performance of each type of sensor. It is necessary to develop procurement specifications to establish acceptable sensor performance limits. Careful explanation and inspection of critical installation dimensions is required during on-site construction. The implementation of these activities at a particular site is discussed.

54074 (SAND—77-0996C, pp 11p, Paper B) **Alarm assessment.** McGovern, D.E. 1977.

In Perimeter intrusion detection and assessment system.

Alarms must be assessed to determine the cause of the alarm and what response action is required. Some information on cause can be derived through proper application and processing of sensor inputs. The final determination of cause and the initiation of required response is derived, however, from observation of the alarm area by a security system operator. This can be done directly (manned guard towers on the perimeter) or remotely (closed circuit television), and real-time (coincident with the alarm) or delayed (post event analysis). Methods to perform assessment are discussed, and the application of these methods in an installed site are detailed.

54075 (SAND—77-0996C, pp 11p, Paper C) **System control and display.** Jacobs, J. 1977.

In Perimeter intrusion detection and assessment system.

The system described was designed, developed, and installed on short time scales and primarily utilized of-the-shelf military and commercial hardware. The system was designed to provide security-in-depth and multiple security options with several stages of redundancy. Under normal operating conditions, the system is computer controlled with manual backup during abnormal conditions. Sensor alarm data are processed in conjunction with weather data to reduce nuisance alarms. A structured approach is used to order alarmed sectors for assessment. Alarm and video information is presented to security personnel in an interactive mode. Historical operational data are recorded for system evaluation.

54076 (UCRL—79216) **Dynamic models, estimation and detection concepts for safeguarding $Pu(NO_3)_4$ storage tanks.** Dunn, D.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1977. Contract W-7405-ENG-48. 12p. (CONF-770656—2). Dep. NTIS, PC A02/MF A01.

From Annual meeting of the Institute of Nuclear Materials Management; Washington, District of Columbia, United States of America (USA) (29 Jun 1977).

The applicability of modern signal processing techniques to the safeguards problem for a plutonium nitrate storage tank is addressed. The techniques involve mathematical modeling, optimal estimation of process variables and the detection of abnormal changes in these variables due to adversary diversion. An example is given which shows overall performance in terms of probabilities of detection versus false alarm probabilities for levels of diversion of 150, 250, and 500 g.

54077 **Ministerial Decree of 16 February 1976 relating to approval of the model certificate of financial security for the transport of radioactive materials.** *Geburtshilfe Frauenheilkd.;* No. 77, 2197-2200(24 Mar 1976). (In Italian).

This Decree by the Minister of Industry, Commerce and Crafts, in consultation with the Minister of Transport, approves the model certificate of financial security for the transport of nuclear materials. This type of certificate issued by nuclear insurers is intended to provide detailed information on the nature of the financial security for damage likely to be caused by the materials in the course of transport; it is required to supply the certificate according to the Paris Convention on Third Party Liability in the Field of Nuclear Energy, ratified by Italy in 1975. The standardized presentation of this certificate enables it to be used in international transport between countries parties to the Paris Convention as proof of the existence of the financial security.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

54078 (MLM—2403) **Stable isotope sales: Mound Laboratory customer and shipment summaries, FY 1976 and FY 1976A.** Ruwe, A.H. Jr. (comp.). (Mound Lab., Miamisburg, Ohio (USA)). 6 Jun 1977. Contract EY-76-C-04-0053. 26p. Dep. NTIS, PC A03/MF A01.

A listing is given of Mound Laboratory's sales of stable isotopes of noble gases, carbon, oxygen, nitrogen, chlorine, and sulfur for fiscal years 1976 and 1976A (the period July 1, 1975 through September 30, 1976). Purchasers are listed alphabetically and are divided into domestic and foreign groups. A cross-reference index by location is included for domestic customers. Cross-reference listings by isotope purchased are included for all customers.

PHYSICAL ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 54218

54079 (IS-M—89) **Problem of obtaining optimum brightness from your LaB_6 gun.** Verhoeven, J.D. (Ames Lab., Iowa (USA)). 1977. Contract W-7405-ENG-82. 7p. (CONF-770333—6). Dep. NTIS, PC A02/MF A01.

From IITRI scanning electron microscopy symposium; Chicago, Illinois, United States of America (USA) (29 Mar 1977).

A discussion of the factors which control the brightness and lifetime of LaB_6 cathodes is presented. A short discussion of the role of each factor and how it should be controlled to optimize brightness is presented. In addition, a brief discussion is presented of how one may evaluate cathode brightness.

54080 **Fast tape transport system for use with on-line separators.** MacDonald, J.A.; Hardy, J.C.; Schmeing, H.; Bray, N.C.; Perry, W.; Walker, R.B.; Wightman, M. (Chalk River Nuclear Labs., Ont.). *Nucl. Instrum. Methods;* **139**: 355-357(1976).

A fast tape transport system has been developed for transporting samples collected from the on beam of an isotope separator to a low background area. The unusual features of the system are its tape speed (up to 585 cm/s) and the fact that the tape system operates entirely in air except for the collection point on the tape at the end of the beam line.

54081 **Measurements on rotating noble gas arcs.** Mueck, G.; Simon, M. (Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany, F.R.)). *Verh. Dtsch. Phys. Ges.;* No. 3, 667(1977). (In German).

From Meeting on plasma and high-speed physics of the Deutsche Physikalische Gesellschaft e.V.; Essen, Germany, F.R. (7 - 10 Mar 1977).

Short communication only.

HYDROGEN

PRODUCTION

ELECTROLYSIS

54082 **Generation of hydrogen with nuclear process heat.** Knoche, K.F. (Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Technische Thermodynamik und Inst. fuer Thermodynamik). *Chem.-Ing.-Tech.;* **49**: No. 3, 238-242(Mar 1977). (In German).

From Annual meeting of process engineers and 175. meeting of the European Federation of Chemical Engineering; Duesseldorf, Ger. (29 Sep - 1 Oct 1976).

Utilization of nuclear energy for producing gaseous secondary energy sources (synthesis gas, methane, hydrogen) has attracted increasing interest in recent years. In the long term, hydrogen should be produced exclusively from water without use of fossil fuels; it is regarded as a particularly versatile fuel having excellent non-pollutive combustion properties. The necessary energy should come from high temperature reactors. Some of the most promising processes are described and the attainable efficiency analysed.

THERMOCHEMICAL PROCESSES

54083 **High temperature corrosion in the thermochemical hydrogen production from nuclear heat.** Coen-Porisini, F.; Imarisio, G. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). *Rev. Int. Hautes Temp. Refract.;* **13**: No. 4, 250-261(1976).

From 1. Petten colloquium on advanced high temperature material: technological and industrial aspects; Petten, Netherlands (29 - 30 Jan 1976).

In the production of hydrogen by water decomposition utilizing nuclear heat, a multistep process has to be employed. Water and the intermediate chemical products react in chemical cycles giving hydrogen and oxygen with regeneration of the primary products used. Three cycles are examined, characterized by the presence of halide compounds and particularly hydracids at temperatures up to 800°C. Corrosion tests were carried out in hydrobromic acid, hydrochloric acid, ferric chloride solutions, and hydriodic acid.

COAL GASIFICATION

REFER ALSO TO CITATION(S) 53621

STORAGE

REFER ALSO TO CITATION(S) 54082

CHEMISORPTION

REFER ALSO TO CITATION(S) 54851

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 53947

PROPERTIES

54084 **Investigation of a turbulent impeller-less burner at chemical non-balance.** Oyegbesan, A.O.; Algermissen, J. *Brennst.-Waerme-Kraft;* **29**: No. 3, 99-103(Mar 1977). (In German).

The complex exchange and reaction processes in a hydrogen/oxygen flame are numerically analyzed. For the description of the transporting processes, which are increased by local turbulent fluctuation movements, four different semi-empirical starting data have been used. The course of reaction was based on a reduction mechanism with 23 elementary reactions between the nine components H_2, O_2, H, O, OH, H_2O, HO_2, H_2O_2, and O_3. The system of partial differential equations which describes the process is solved with an explicit method of differences. The field distributions of the flow velocity, the temperature and mass proportion of the various chemical components are described. The calculation shows that the various turbulence models for the flow field result in noticeably different profiles of the calculated field variables. With one exception, the maximum value of the mass proportions for the most important reaction products agree well for the various cases of comparison.

OTHER SYNTHETIC AND NATURAL FUELS

REFER ALSO TO CITATION(S) 53620, 54873

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 53638

PROPERTIES

REFER ALSO TO CITATION(S) 53812, 54924, 54945

PREPARATION

REFER ALSO TO CITATION(S) 53623

CHEMICAL SYNTHESIS

54085 (PB—266640) **Waste stone oxidation and recarbonization.** Craig, J.W.T.; O'Neill, E.P.; Kearns, D.L. (Environmental Protection Agency, Washington, D.C. (USA)). 29 Jun 1976. 5p.

The disclosed process provides for the production of a desulfurized fuel gas from a sulfur-containing fuel oil by absorption, in a first reaction zone, of the sulfur contaminants with a calcium oxide-containing material, which material is then further treated to render it environmentally stable without producing a sulfur-rich gas process stream. The spent limestone from the oil gasifier is reacted with an oxygen-containing gas in a second reaction zone for conversion of the calcium sulfide to calcium sulfate and the sulfated material is then transferred to a third reaction zone wherein it is reacted with carbon dioxide for conversion of the calcium oxide to calcium carbonate.

54086 Ionic hydrogenolysis of Binor-S for use as a high energy fuel. Schneider, A.; Janoski, E.J. (to Sun Ventures, Inc.). US Patent 4,033,799. 5 Jul 1977. Filed date 16 May 1975. 12p.

Ionic hydrogenolysis of Binor-S, a C_{14} heptacyclic saturated hydrocarbon, yields a low melting point product containing predominantly hexacyclics and lesser amounts of pentacyclics. Hydrogenolysis occurs at about 50 to 200°C and at about 100 to 10,000 psig in the presence of a palladium-on-carbon catalyst, palladium-on-alumina or Raney nickel and is promoted by a hydrogen halide or its equivalent. Resulting product has utility as a high energy fuel.

PREPARATION FROM WASTES OR BIOMASS

54087 (COO—2982-15) **Progress report, May 1977.** Kuester, J.L. (Arizona State Univ., Tempe (USA). Coll. of Engineering and Applied Sciences). 1977. Contract EY-76-S-02-2982. 9p. Dep. NTIS, PC A02/MF A01.

Preliminary results obtained in three reaction systems (Fischer-Tropsch reactor, reformer reactor, and pyrolysis reactor) for the production of various grades of liquid fuel from cellulosic and waste polymer material are briefly reviewed. A preliminary material and energy balance summary is also included. (JSR)

54088 (PERC/RI—77/9) **Combustion of char from pyrolyzed wood waste.** Demeter, J.J.; McCan, C.R.; Ekmann, J.M.; Bienstock, D. (Energy Research and Development Administration, Pittsburgh, Pa. (USA). Pittsburgh Energy Research Center). Jul 1977. 28p. Dep. NTIS, PC A03/MF A01.

The combustion and handling characteristics of char produced by pyrolysis of wood waste were determined in a 500 lb/hr pulverized-coal-fired (PCF) combustion test facility and as a slurry with No. 6 oil in a 100 HP oil-fired boiler. In the PCF combustor, tests were also run with a 50-50 blend of Pittsburgh-seam high-volatile coal with a high-volatile pyrolytic char as well as with a low-volatile pyrolytic char. Stable combustion could be maintained with a secondary air-preheat temperature of 600°F, the temperature generally used when firing coal, at a carbon-combustion efficiency of 97.3 to 98.6 percent. With the low-nitrogen content of the char, nitrogen oxide emissions were very much lower than those obtained from coal (0.25 compared to 0.80 lb $NO_x/10^6$ Btu) at the same firing conditions. The NO/sub x/ emissions obtained with the 50-50 blends appeared to be an average of the values obtained for the fuels separately. Similarly, the SO_2 emission was low with the char alone (0.18 lb $SO_2/10^6$ Btu), and the emissions obtained with the blends were an average of the values obtained with the fuels separately. A 60-40 blend of pulverized char and the oil produced during pyrolysis combined with No. 6 fuel oil to obtain a slurry containing 30 percent char performed well in a 100 HP oil-fired firetube boiler modified to fire coal-oil slurries. Excellent flame stability was experienced and the carbon-combustion efficiency was similar to that obtained with No. 6 fuel oil and coal-oil slurry. Nitrogen oxide emissions were significantly lower than those obtained when firing coal-oil slurry, and the SO_2 emissions were about 50 percent lower. Some fouling of the small ports in the burner nozzle was experienced due to the accumulation of small fibers passing through the filter screen.

54089 Fuel making process. Hess, H.V.; Franz, W.F.; Cole, E.L. (to Texaco Inc.). US Patent 4,014,661. 29 Mar 1977. Filed date 17 Mar 1975. 4p.

A process is disclosed for making a hydrocarbon coke slurry fuel by coking carbonaceous materials in the liquid phase under autogenous pressure to form coke which is then extracted with a combustible hydrocarbon at high temperatures and pressures to produce a dense slurry of coke in the hydrocarbon suitable for use as a fuel. 5 claims, 1 figure.

54090 Process for making oil from aqueous reactive sludges and slurries. Hess, H.V.; Franz, W.F.; Cole, E.L. (to Texaco Inc.). US Patent 4,030,981. 21 Jun 1977. Filed date 16 Dec 1974. 4p.

A process is claimed for making low sulfur oil by reacting aqueous reactive sludges and slurries with hot, pressurized carbon monoxide and hydrogen (synthesis gas) wherein the wastes are first concentrated by coking in the liquid phase under a pressure of 300 to 3000 psig at a temperature of 400 to 550°F for from 5 minutes to 2 hours.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 54762

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 54710

HYDRO ENERGY

PLANT DESIGN AND OPERATION

54091 (PB—265499-T/SL) **High power turbo- and hydro-generators and their development prospects.** Gredin, L.P.; Danilevich, Ya.B.; Anempodistov, V.P. (Bureau of Reclamation, Washington, D.C. (USA)). 1974. 383p. (TT—74-55030). NTIS, PC A17/MF A01.

Papers on the design, development, and performance of turbo and hydroelectric generators are presented.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 54656

SOLAR ENERGY

REFER ALSO TO CITATION(S) 54649, 54709

54092 (AD-A—038600) **Solar energy. Report bibliography Jan 55—Dec 76.** (Defense Documentation Center, Alexandria, Va. (USA)). Apr 1977. 211p. (DDC/BIB—77/03). NTIS PCA10/MF A01.

See also AD—771750.

This bibliography is a selection of unclassified and unlimited distribution references on Solar Energy. These citations of reports present information on performance characteristics, fabrication, development of power levels and energy conversion. Corporate Author-Monitoring Agency, Subject, Title and Personal Author are provided.

54093 (NP—22131) **Proposed objectives for a Solar Energy Development Program in Illinois.** (Illinois Dept. of Business and Economic Development, Springfield (USA). Div. of Energy). Mar 1975. 15p. Dept. of Business and Economic Development, Springfield, IL.

The purpose of the Illinois Solar Energy Program is to develop the state's maximum capability for solar energy technology as soon as possible, thereby diversifying their energy base consistent with economic reasonableness and technological feasibility. The program will provide coordination of the state's efforts with those of the Federal government and the private sector. This will be done to maximize productivity and minimize duplication of research and development effort. This document outlines the general areas of activities proposed under the Illinois Solar Energy Development Program and invites response from all interested parties within the State of Illinois. The input from all sectors will be evaluated and developed into a comprehensive solar energy implementation plan for the state. Public hearings will be held prior to finalizing this program.

RESOURCES AND AVAILABILITY

54094 Instrumentation for the measurement of the variation, quantity, and quality of sun and sky radiation. Klein, W.H.; Goldberg, B.; Shropshire, W. Jr. (Smithsonian Radiation Biology Lab., Rockville, MD). *Sol. Energy;* **19**: No. 2, 115-122(1977).

From ISES international solar energy congress and exposition; Los Angeles, CA, USA (28 Jul 1975).

Many biological responses, such as reproduction, differentiation and morphological development are regulated by radiant energy in particular wavelengths of the solar spectrum. Biologists are concerned with the influence of the spectral quality of natural daylight on these biological responses. Data, concerning spectral quality of daylight over a sufficient time period, required by biologists are usually not available. The described system will provide the information with sufficient accuracy and precision to discern small but significant changes. To produce such a monitoring system, a

standardization program was evolved using the original Smithsonian solar standards and instruments. These were compared to each other and finally to commercial units which were used in the monitoring system. The system was designed so that data would be accurate at 0.01 ly min^{-1} and could be automated to give high precision readings every 3 min with errors less than 2 percent.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 53707, 54113

54095 (SAND—77-0172) **Environmental issues associated with solar heating and cooling of residential dwellings.** Brannon, P.J.; Church, H.W.; Luna, R.E.; Thomas, W.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Apr 1977. Contract EY-76-C-04-0789. 47p. Dep. NTIS, PC A03/MF A01.

The negative issues associated with solar heating and cooling of residential dwellings were surveyed. Effects which were addressed as possibly significant include: (1) heat transfer fluids and storage media hazards, (2) material resources usage, (3) architectural and aesthetic changes, (4) air pollution due to outgassing or evaporation losses, (5) reflected light hazards, and (6) legal questions arising from reflected light nuisances and solar rights. The magnitudes of these environmental effects were compared to similar effects from common sources whenever possible.

54096 (UCRL—78855) **Possible climatic impact of large scale solar thermal energy production.** Potter, G.L.; MacCracken, M.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1977. Contract W-7405-ENG-48. 16p. (CONF-761223—1). Dep. NTIS, PC A03/MF A01.

From International workshop on climate and solar energy conversion; Schloss Laxenburg, Austria (8 Dec 1976).

The ZAM2 (zonal atmospheric model) was used to estimate the climatic effects of large scale solar thermal power facilities. The results appear to be consistent with other numerical experiments. The model response can be summarized by tracing through a feedback loop: decreased surface albedo yields warmer surface yields increased evaporation and increased convection yields increased precipitation in the subtropics and increased water vapor in high latitudes yields increased surface temperatures at high latitudes yields decreased equator-to-pole temperature gradient yields decreased Hadley cell intensity yields possible northward shift of the ITCZ (intertropical convergence zone). The experiment also resulted in a warmer upper troposphere, particularly over the latitudes of maximum area of albedo change. The response was noted in Ellsaesser et al. (1976). The increased surface energy subsequently increased surface absolute humidity which in turn displaced the convective parcel ascent curve to the right (indicating more water vapor and latent heat release) making the lapse rate less steep and warmer where the water vapor content was lowest. It should be noted that ZAM2 has previously been shown to duplicate quite well the results of a 3-D GCM for large surface perturbations, which is important because it is questionable whether experiments looking at such small changes in local albedo as reported here would be possible given the synoptic variability inherent in 3-D models.

SOLAR ENERGY CONVERSION

PHOTOVOLTAIC CONVERSION

54097 (COO—4094-3) **Photovoltaic applications in the southwest for the National Park Service.** Peatfield, C.R.; Jarvinen, P.O. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 28 Apr 1977. Contract EY-76-C-02-4094. 38p. Dep. NTIS, PC A03/MF A01.

Nearly three megawatts of electrical power are produced annually by diesel/electric generator sets at National Park Service sites, according to a survey conducted jointly by the NPS and MIT/Lincoln Laboratory. To prove the economic viability of photovoltaic power generation systems to meet NPS electric power needs as well as to stimulate public acceptance and reliance on solar-generated electricity, NPS and MIT/LL are cooperating in a Field Tests and Applications Project sponsored by the U.S. Energy Research and Development Administration. The power level for the applications will be in the range from 10 to 100 kW. Ten of the most promising NPS sites were visited and evaluated. Based on ten criteria, Natural Bridges National Monument in Utah was selected as the optimum first pick. The FT and A Project and evaluation details for the ten sites are described.

54098 (ERDA/JPL/954334—76/4) **Establishment of the feasibility of a process capable of low cost, high volume production of silane, SiH_4. Low cost silicon solar array project, Task I. Quarterly progress report, July 1976—October 1976.** Breneman, W.C.; Mui, J.Y.P. (Union Carbide Corp., Sistersville, W.Va. (USA)). 15 Oct 1976. Contract NAS-7-100-954334. 58p. Dep. NTIS, PC A04/MF A01.

The study of a process for the low cost production of silane included laboratory investigations of the kinetics of the redistribution of dichlorosilane and trichlorosilane vapor over a tertiary amine ion exchange resin catalyst. The hydrogenation of $SiCl_4$ to form $HSiCl_3$ and the direct synthesis of H_2SiCl_2 from HCl gas and metallurigical silicon metal were also studied. The purification of SiH_4 using activated carbon adsorbent was studied along with a process for storing SiH_4 adsorbed on carbon. The latter makes possible a higher volumetric efficiency than the current practice of compressed gas storage. The mini-plant designed to produce ten pounds per day of SiH_4 is nearly complete, a detailed description of the unit and its essential design features are given.

54099 (ERDA/JPL/954560—77/1) **Synthesis of silane and silicon in a nonequilibrium plasma jet. Third quarterly report, December 21, 1976—March 20, 1977. (AeroChem(TN)—17).** Calcote, H.F.; Felder, W. (Aerochem Research Labs., Inc., Princeton, N.J. (USA)). Mar 1977. Contract NAS-7-100-954560. 39p. Dep. NTIS, PC A03/MF A01.

The objective of this program is to determine the feasibility of high volume, low-cost production of high purity silane or solar grade silicon using a non-equilibrium hydrogen atom plasma jet. Reactions of hydrogen atoms in the plasma jet with chlorosilanes (added either to the discharge or to the hydrogen atom stream) are being studied. Calculations were made to define the experimental limits within which gas-phase reactions would be most likely to occur. These show that H-atom recombination does not compete significantly with reaction as a sink for H, and that, if the $H/SiCl_4$ overall reaction has an activation energy, the pressure ratio across the nozzle and the temperature in the discharge become very important parameters. Most importantly, the maximum operating pressure is shown to be limited by the pressure at which the glow discharge can be maintained or the pressure at which the hydrogen atom yields become small. Solid products of the $H/H_2/SiCl_4$ reaction were recovered. Depending upon experimental conditions, these were (tentatively) identified as a polymeric material, amorphous silicon and polycrystalline silicon. The polycrystalline material was shown by X-ray fluorescence analysis to have ppm levels of nickel present, but conspicuously absent at the ppm level were the heavy metals Fe, Cr, Pb, Sn, Cu, and Zn, materials of construction of the apparatus.

54100 (ERDA/NASA/1022—76/2) **Effect of atmospheric parameters on silicon cell performance.** Curtis, H.B. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1976. Contract EX-76-A-29-1022. 20p. (CONF-761129—4). Dep. NTIS, PC A02/MF A01.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, United States of America (USA) (10 Nov 1976).

The effects of changing atmospheric parameters on the performance of a typical silicon solar cell have been calculated. The precipitable water vapor content, airmass and turbidity were varied over wide ranges and the normal terrestrial distribution of spectral irradiance was calculated. The cell short-circuit current was then computed for each spectral irradiance distribution using the cell spectral response. Data are presented in the form of calibration number (cell current/incident irradiance) vs. water vapor content or turbidity.

54101 (ERDA/NASA/1022—76/3) **Errors in short circuit current measurements due to spectral mismatch between sunlight and solar simulators.** Curtis, H.B. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1976. Contract EX-76-A-29-1022. 26p. (CONF-761129—5). Dep. NTIS, PC A02/MF A01.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, United States of America (USA) (10 Nov 1976).

Errors in short-circuit-current measurement were calculated for a variety of spectral mismatch conditions. Parameters included were the differences in spectral irradiance between terrestrial sunlight and three types of solar simulator, as well as the differences in spectral response between three types of reference solar cells and various test cells. The simulators considered are a short-arc xenon-lamp AMO sunlight simulator, an ordinary quartz halogen lamp, and ELH-type quartz-halogen lamp. The three types of solar cell are a silicon cell, a cadmium sulfide cell and a gallium arsenide cell.

54102 (N—77—17564) **Solar cell collector and method for producing same.** Evans, J.C. Jr. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 22 Feb 1977. 16p. NTIS, PC A02/MF A01.

A method is described which permits the formation of highly conductive metal channels in a continuous pattern of any desired design within a transparent conductive mixed oxide layer which covers and protects an underlying photovoltaic substrate. The result is a sufficient collector system for the current generated by incident photon radiation.

54103 (N—77—17565) **Improved backwall cell.** Brandhorst, H.W. Jr. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 19 Jan 1977. 15p. NTIS, PC A02/MF A01.

A solar cell is described having a first material of one conductivity type with one face having the same conductivity type more heavily doped to form a field region to receive the radiant energy. A layer of opposite conductivity type or a metallic layer forming a Schottky barrier is applied to the opposite face. A gridded contact pervious to the radiant energy may be applied to the region of the more heavily doped material for electrical contact. The device allows separate control of the junction, either the p-n junction or the Schottky diode junction, and the efficient collection of light. This efficiency is improved, because the high conductivity region has low sheet resistance, and a low surface recombination velocity with enhanced effective diffusion lengths in bulk.

54104 (N—77—17566) **Thick-film materials for silicon photovoltaic cell manufacture. Final report.** Field, M.B. (Owens-Illinois, Inc., Toledo, Ohio (USA)). Jan 1977. Contract NAS3-19441. 22p. (NASA-CR—135134). NTIS, PC A02/MF A01.

Thick film technology is applicable to three areas of silicon solar cell fabrication; metallization, junction formation, and coating for protection of screened ohmic contacts, particularly wrap around contacts, interconnection and environmental protection. Both material and process parameters were investigated. Printed ohmic contacts on n- and p-type silicon are very sensitive to the processing parameters of firing time, temperature, and atmosphere. Wrap around contacts are easily achieved by first printing and firing a dielectric over the edge and subsequently applying a low firing temperature conductor. Interconnection of cells into arrays can be achieved by printing and cofiring thick film metal pastes, soldering, or with heat curing conductive epoxies on low cost substrates. Printed (thick) film vitreous protection coatings do not yet offer sufficient optical uniformity and transparency for use on silicon. A sprayed, heat curable SiO_2 based resin shows promise of providing both optical matching and environmental protection.

54105 (N—77—17586) **Specification for silicon solar cells.** (European Space Research and Technology Centre, Noordwijk (Netherlands)). 1 Jun 1976. 48p. NTIS, PC A03/MF A01.

The requirements for the qualification, procurement, storage and delivery of silicon solar cells for use in spacecraft applications are outlined. The general requirements are covered in the main part of the specification, the generic specification. Moreover, the recommended format for the specification of specific test and inspection data, physical and electrical characteristics and other ratings which are expected to be different for each application is included.

54106 (N—77—17587) **Meteosat solar-cell array qualification of the substrate-to-cell adhesive.** Gourmelon, G. (European Space Research and Technology Centre, Noordwijk (Netherlands)). Sep 1976. 36p. NTIS, PC A03/MF A01.

Results of qualification tests are summarized. Data reported were obtained from tests on individual solar cells bounded to Kapton substrate.

54107 (SAND—76-0737) **Structural effects in chemically sprayed CdS/Cu/sub x/S photovoltaic cells.** Berg, R.S.; Nasby, R.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). May 1977. Contract EY-76-C-04-3579. 40p. Dep. NTIS, PC A03/MF A01.

Cadmium sulfide/copper sulfide photovoltaic devices have shown a great deal of promise for economic power generation. One of the most interesting fabrication techniques for these devices is a chemical spray technique that can be integrated into a float glass substrate plant. This technique utilizes pyrolysis of chemical solutions by spraying onto hot substrates. Here, the structures and morphologies of the various layers of the cell are described and the growth characteristics discussed. The effects of the resulting structures on device properties are discussed. A predominant feature of the CdS film is a complex morphology with small crystallite size. These features are also found in the Cu/sub x/S since it is formed by an ion exchange process into the CdS surface. The resulting structure produces increased ion carrier recombination and thus reduces open circuit voltage, short circuit current, and device efficiency. The junction morphology is also extremely complex, which further reduces the open circuit voltage. Cell efficiencies of 5.5% with open circuit voltages of 0.41 V have been produced.

54108 **Photovoltaic solar energy conversion.** Srobar, F. (CSAV, Prague). *Cesk. Cas. Fys.;* **26**: No. 5, 449-463(1976). (In Czech).

Photovoltaic phenomena present one of the most promising ways of direct conversion of solar energy into electricity. This review article contains information concerning physics of the photovoltaic phenomena in p-n junctions, heterojunctions and Schottky barriers as well as the related materials and construction aspects of the contemporary solar cells. Special emphasis is placed on a due analysis of the factors determining the overall conversion efficiency.

54109 **Status of the U.S. photovoltaic conversion program.** Magid, L.M. (Energy Research and Development Administration, Washington, DC). pp 22 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

54110 **Combined solar electric and thermal system for use in individual family housing.** Shewchun, J. (McMaster Univ., Hamilton, Ont.); Thompson, D.A.; St. Pierre, J.A.; Liikala, R.; Haber, C.J.; Carter, R. pp 106-107 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 54097

54111 **Techno-economic aspects of a photovoltaic electric power system interfaced with electric power utilities.** Bradley, J.O.; Costello, D.R. (Midwest Research Inst., Kansas City, MO). pp 159-161 of In Sharing the Sun: solar technology in the seventies. Volume 6. Boeer, K.W. (ed.). Cape Canaveral, FL; American Section of the International Solar Energy Society (1976).

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.; Winnipeg, Manitoba, Canada (15 Aug 1976).

See CONF-760842—P6.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 54096

TOWER FOCUS POWER PLANTS

54112 (PB—265651) **Feasibility of solar energy for feedlot operation and irrigation pumping. Final report 1 May 75-31 Dec 76.** Hildebrandt, A.F.; Strickland, J.H.; Larson, D.L.; Puckett, H.B. (Arizona Univ., Tucson (USA). Dept. of Soils, Water and Engineering). Jan 1977. 567p. NTIS, PC A24/MF A01.

A tower-heliostat solar energy collector system is feasible for the production of 600 K steam in the one to ten Megawatt-thermal range. It is feasible to power a feedmill and associated equipment for a 30 thousand head cattle feedlot or larger with solar energy if fuel cost increases at the rate of eight percent per year. In Arizona it is economical to power an irrigation system with solar energy with an eight percent per year increase in electricity per year using a base electricity cost of 25 mills. This report covers design, cost, and performance of various kinds of solar collectors and concentrators.

54113 (SAN/1110—76/3) **Central receiver solar thermal power system, Phase 1. Annual progress report (final) for period ending September 30, 1976.** (Martin Marietta Corp., Denver, Colo. (USA)). Feb 1977. Contract EY-76-S-03-1110. 209p. (MCR—76-526). Dep. NTIS, PC A10/MF A01.

The program activities since the beginning of the program in July of 1975 through September of 1976 are summarized. The primary efforts during the first portion of this period were the preparation of the Pilot Plant Preliminary Design Baseline, and the Conceptual Design of the three subsystem research experiments. The Preliminary Design Baseline for the Pilot Plant was developed from the commercial plant conceptual design that had been defined prior to the start of this program. It definitized each of the basic Pilot Plant Subsystems and provided the basis for development of the conceptual designs of the research experiments. For each of the solar peculiar subsystems, the Collector Subsystem, the Receiver Subsystem and the Thermal Storage Subsystem, a subsystem research experiment was planned. The Conceptual Design of each of these experiments was prepared and reviewed with ERDA and Sandia in order to obtain authorization for the design, build and test of these experiments. In the Collector Subsystem experiment the design was completed, the four experimental heliostats have been fabricated and erected. Initial calorimeter and radiometer data have been obtained and have demonstrated good correlation with the projected performance. The 5 megawatt thermal experiment receiver has been fabri-

cated by Foster Wheeler Energy Corporation and is now completing erection at the Radiant Heat Test Facility at Sandia in Albuquerque, New Mexico. This testing is scheduled for the period from December 1976 through February 1977. The Thermal Storage Research Experiment fabrication and erection is nearing completion by Georgia Institute of Technology. Checkout of this experiment is scheduled for the first of December 1976 with the test program to be complete by the end of January 1977.

54114 (SAND—76-9104C) **Solar absorption properties of a high temperature direct-absorbing heat transfer fluid.** Drotning, W.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 28p. (CONF-770537—7). Dep. NTIS, PC A04/MF A01.

From 7. symposium on thermophysical properties; Gaithersburg, Maryland, United States of America (USA) (10 May 1977).

The optical absorption properties of a high temperature molten salt heat transfer fluid, a eutectic mixture of KNO_3, $NaNO_2$, and $NaNO_3$, known as Hitec (DuPont trade name), were measured from 0.35 μm to 2.5 μm using hemispherical transmission techniques. To enhance solar absorption, particulate metallic oxides of Co or Cu were introduced into the fluid. Absorption spectra of these oxide particle suspensions in the molten salt were determined as a function of dopant concentration ranging from 0 to 0.1 wt percent metal nitrate added to the Hitec. These measurements were carried out at 473 K under flow conditions to cause a homogeneous suspension of particles. Absorption coefficients at a single wavelength were measured up to dopant concentrations of 0.5 wt percent. The suspended particles cause an additional optical absorption throughout the visible spectrum, which is characteristic of the particular metallic oxide and closely follows a Beer-Lambert concentration dependence. The solar-averaged absorption in a fixed layer thickness was calculated for various concentrations of the fluid-oxide mixtures. The fluid without oxide particles absorbs approximately 8 percent of the solar spectrum per cm of path length, while addition of 0.1 wt percent of $Co(NO_3)_2 \cdot 6H_2O$ increases this absorption to approximately 93 percent per cm. An equivalent wt percent of $Cu(NO_3)_2 \cdot 3H_2O$ causes a solar-averaged absorption of 84.4 percent per cm. Effects of particulate scattering on the measurements are discussed.

54115 **Solar-heated-air receivers.** Jarvinen, P.O. (Massachussetts Inst. of Tech., Lexington). *Sol. Energy;* **19**: No. 2, 139-147(1977).

From ISES international solar energy congress and exposition; Los Angeles, CA, USA (28 Jul 1975).

Receiver design alternatives for a central tower, heat-air receiver of a solar/gas turbine electrical generation plant are considered. Apertured and unapertured, domed-surface and -cavity receivers are examined and losses such as incident flux reflection and reradiation from the receiver are included. The receiver, constructed of ceramic domes that are individually cooled by impingement-jet heat-transfer techniques, is designed to supply heated air at 1800°F and operate in a pressurized condition at a pressure ratio of four. It is shown that high thermal conversion efficiencies (80 to 90 percent) may be achieved with cavity receivers where the interior cavity surfaces are formed from single or multiple domes. The efficiencies of surface receiver elements are found to be substantially less than those of cavities, from 54 to 70 percent. The difference lies in the higher reradiation flux losses of surface receivers.

OCEAN THERMAL GRADIENT POWER PLANTS

REFER ALSO TO CITATION(S) 54202, 54203

54116 (AD-A—038752) **The nature of primary organic films in the marine environment and their significance for ocean thermal energy conversion (OTEC) heat exchange surfaces. Technical report.** Haderlie, E.C. (Naval Postgraduate School, Monterey, Calif. (USA)). Feb 1977. 47p. (NPS—68Hc77021). NTIS PCA03/MF A01.

The development of bacterial slime films on the heat exchanger surfaces of OTEC power plants is likely to be of critical importance in determining if OTEC closed cycle systems are technically and economically viable. This report surveys our present state of knowledge as to the nature and behavior of primary films in the marine environment. Areas where further research is needed are indicated. The report contains an extensive bibliography.

54117 (COO—2946-1, pp A.1-A.34) **Utilization of the energy from salinity gradients.** Wick, G.L.; Isaacs, J.D. (Univ. of California, San Diego, La Jolla). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976).

In Wave and salinity gradient energy conversion.

Various methods of producing power from salinity gradients in the ocean, river mouths, and salt lakes are discussed. These methods are divided into "brute force", pressure retarded osmosis, reverse electrodialysis, and toroidal reverse electrodialysis and are sketched. The feasibility, environmental effects, membranes, and economics of these methods are discussed. (MHR)

54118 (COO—2946-1, pp B.1-B.17) **Osmotic work. Energy production from osmosis of fresh water/saline water systems.** Jellinek, H.H.G. (Clarkson Coll. of Tech., Potsdam, NY). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976).

In Wave and salinity gradient energy conversion.

Salination processes are discussed which can extract energy by mixing fresh water (i.e., river water) with electrolyte solutions (i.e., sea water) via semipermeable membrances. This energy obtained either as kinetic or potential energy (or both) can be transformed into electrical energy. Cost estimates range from $0.01 to $0.03 per kw hr. This compares favorably with electrical energy from nuclear fission and with that yielded by fossil fuels. The six largest rivers in the U.S. can ideally produce 7×10^{-7} kw, i.e., about 10 percent of the total production of electrical power produced in the U.S. in 1970. Osmotic work can be obtained not only near estuaries but from any location where salt deposits or salt lakes and fresh water are available. Any ecological disturbance at estuaries can be minimized by using part of the river flow and conducting diluted sea water back to the mouth of the estuary. The osmopower process does not produce air or water pollution and does not present any hazards due to radioactivity.

54119 (COO—2946-1, pp B.18-B.22) **Direct conversion of chemical energy into work.** Jellinek, H.H.G. (Clarkson Coll. of Tech., Potsdam, NY). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976).

In Wave and salinity gradient energy conversion.

It is feasible to transfer the extension and contraction of polymer strips in electrolyte solutions into a cyclical process. In other words, chemical energy can be converted by mechanical devices into mechanical energy and further into electrical energy. Data on such machines are almost completely lacking. One notable system would be the saline water (sea water/fresh water [river water]) system where free energy of the dilution process of sea water is changed eventually into electrical energy by making the process cyclical.

54120 (COO—2946-1, pp B.23-B.27) **Power from reverse electrodialysis.** Jellinek, H.H.G. (Clarkson Coll. of Tech., Potsdam, NY). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976).

In Wave and salinity gradient energy conversion.

Reverse electrodialysis can be achieved by a battery of anionic and cationic pairs of membranes with sea water and river water compartments respectively. However, the power output is about 100 times smaller than that for the osmotic process. In addition not one membrane of suitable area is needed as is the case for the osmotic process but a multitude of membrane pairs are required. Hence reverse electrodialysis is very much less economical than the osmotic process.

54121 (COO—2946-1, pp B.28-B.31) **Discussion of paper entitled: I. Osmotic work energy production from osmosis of fresh water/saline water systems.** Moore, W.L. (Univ. of Texas, Austin). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976).

In Wave and salinity gradient energy conversion.

Criticism is made on information presented on the possibilities for using osmotic pressure to produce energy in the form of piezometric head, a form of hydraulic energy. Exception is taken to concepts in the previous paper. (MHR)

54122 (COO—2946-1, pp C.1-C.46) **Current status of membrane technology.** Lonsdale, H.K. (Bend Research, Inc., Bend, OR). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976).

In Wave and salinity gradient energy conversion.

The more important uses of membranes are reviewed with emphasis on reverse osmosis. The two main types of membranes are cellulose acetate and an aromatic polyamide-hydrazide. The different configurations of membranes are mentioned: flat sheets, hollow fibers, and tubular. The advantages and disadvantages of these are compared. The reverse osmosis installations in the world as of March 1975 exceeding 25,000 gallons per day capacity have been tabulated in an appendix. (MHR)

54123 (COO/2895—6) **Simplified algorithm to solve geometric programming problems using FORTRAN.** Lepley, M. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). 1 Oct 1976. Contract EY-76-S-02-2895. 40p. Dep. NTIS, PC A03/MF A01.

Geometric Programming has proven to be a useful tool for the optimum design of solar sea power plants. The Carnegie Mellon University team working on the OTEC concept has found it profitable to develop a FORTRAN based computer code to solve simple geometric programs which arise often in OTEC work. This report

describes such a program and gives an outline of how the computer program can be used in general.

54124 (COO/2895—8) **Heat exchanger design using experimental data on fluted vertical tubes. Part I.** Lavi, A.; Rothfus, R.R. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). 31 Oct 1976. Contract EY-76-S-02-2895. 48p. Dep. NTIS, PC A03/MF A01.

Recently, experimental data on the heat transfer characteristics of fluted surfaces have been acquired. As a result, new models must be developed for incorporation in the design process. The new models and a simplified design procedure for OTEC-exchangers are presented without any claim of optimality. The design will be used subsequently to develop cost and layouts for a realizable self-sufficient and a 1 MWe OTEC plant. The same design will be used to investigate the sizing of tributaries and mains in a heat exchanger for a 25 MWe module. The model for the evaporator relates the tube diameter, ammonia feed rate, recycle ratio, and tube length. A similar model for the condenser is obtained, without the recycle ratio. The models derived are shown to be readily usable in an OTEC system optimization.

SOLAR RADIATION UTILIZATION

REFER ALSO TO CITATION(S) 53606

SPACE HEATING AND AIR CONDITIONING

REFER ALSO TO CITATION(S) 54095, 54110

54125 (LA-UR—76-2094) **Solar energy systems for manufactured housing.** Balcomb, J.D. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 14p. (CONF-761091—1). Dep. NTIS, PC A02/MF A01.

From Consumer conference on solar energy development; Albuquerque, New Mexico, United States of America (USA) (2 Oct 1976).

The opportunities for solar energy utilization in manufactured housing such as mobile homes and modular homes are discussed. The general characteristics of the manufactured housing industry are described including market and prices. Special problems of the utilization of liquid heating collectors, air heating collectors, or passive types of solar heating systems in manufactured housing are considered. The market situation for solar energy in manufactured housing is discussed. The design of the Los Alamos Scientific Laboratory mobile/modular home is described.

54126 (LBL—4436) **Control system for solar heating and cooling.** Wahlig, M.; Binnall, E.; Dols, C.; Graven, R.; Selph, F.; Shaw, R.; Simmons, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 20p. (CONF-750712—21). Dep. NTIS, PC A02/MF A01.

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

A control system is being developed that will be capable of operating solar heating and cooling systems covering a wide range of configurations, and using different operating strategies that may be optimal for different climatic regions. To insure widespread applicability of the control system, it is being designed to allow for modification for operating with essentially all practical heating and cooling system configurations and control algorithms simply by interchange of replaceable modules in the circuitry. An experimental heating and cooling system, the main purpose of which is to allow testing and exercise of the controller, was designed so that it could be operated in these various configurations.

54127 (LBL—5911) **Performance of an experimental solar-driven absorption air conditioner. Annual report, July 1975—September 1976.** Dao, K.; Simmons, M.; Wolgast, R.; Wahlig, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1977. Contract W-7405-ENG-48. 67p. Dep. NTIS, PC A04/MF A01.

An important pathway for the use of solar energy for space conditioning of buildings is the development of a heat-actuated air conditioner that can operate with the temperatures available from flat-plate solar collectors and use air cooling for disposal of the waste heat. The solar heating and cooling program of the Lawrence Berkeley Laboratory is exploring the use of the ammonia-water absorption cycle for this purpose. Results of the initial tests of an experimental system that has been fabricated to provide basic engineering data on the operation of the ammonia-water absorption cycle under such conditions are presented. A nominal three-ton, continuous operation, heat-actuated water chiller has been fabricated by drastic modification of a commercial gas-fired unit. The major modifications included designing a new water-heated generator, adding a preheater to the solution circuit, and increasing the flow rate of solution by a factor of about three. The unit was instrumented for measurement of temperatures, pressures, and solution concentrations at points in the circuit. Twenty-two experimental runs have been made and the results analyzed. An analysis of the thermodynamic cycle which includes the finite effectiveness of heat transfer at various points in the cycle is shown to predict with good accuracy the measured values of COP. The measured coefficient of performance agreed with the calculated values over the range 0.4 to 0.75 as the conditions of individual runs were varied. The agreement with the calculated values was within about 5 percent.

54128 (N—77—17198) **Corrosion inhibitors for solar heating and cooling systems.** Humphries, T.S.; Deramus, G.E. Jr. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). Feb 1977. 22p. (NASA-TN-D—8409; M—199). NTIS, PC A02/MF A01.

Problems dealing with corrosion and corrosion protection of solar heating and cooling systems are discussed. A test program was conducted to find suitable and effective corrosion inhibitors for systems employing either water or antifreeze solutions for heat transfer and storage. Aluminum-mild-steel-copper-stainless steel assemblies in electrical contact were used to simulate a multimetallic system which is the type most likely to be employed. Several inhibitors show promise for this application. Effectiveness of corrosion inhibiting solutions containing sodium compounds for aluminum and mild steel sheets at room temperatures and elevated temperatures; variables include degree of chemical attack, solution pH, length to first visual attack, corrosive characteristics, weight loss, and temperature effects; no figures and 6 tables include numeric data.

54129 (N—77—17560) **Optimization of absorption air-conditioning for solar energy applications. Final report, 1 Sep. 1974 - 31 Oct. 1976.** Perry, E.H. (Memphis State Univ., Tenn. (USA). Dept. of Mechanical Engineering). Dec 1976. Contract NAS8-31189. 68p. (NASA-CR—150176). NTIS, PC A04/MF A01.

Improved performance of solar cooling systems using the lithium bromide water absorption cycle is investigated. Included are computer simulations of a solar-cooled house, analyses and measurements of heat transfer rates in absorption system components, and design and fabrication of various system components. A survey of solar collector convection suppression methods is presented.

54130 (ORNL/MIT—229) **Design of a solar energy assisted air conditioning system.** Varlet, J.L.P.; Johnson, B.R.; Vora, J.N. (Massachusetts Inst. of Tech., Oak Ridge, Tenn. (USA). School of Chemical Engineering Practice). 24 Mar 1976. Contract W-740-ENG-26. 35p. Dep. NTIS, PC A03/MF A01.

Energy consumption in air conditioning systems can be reduced by reducing the water content of air before cooling. This reduction in humidity can be accomplished by contacting the humid air with a hygroscopic solution in a spray tower. The hydroscopic solution, diluted by water from the air, can be reconcentrated in a solar evaporator. A solar evaporator for this purpose was evaluated by formulating simultaneous energy and mass balances for forced air convection through the evaporator. Temperatures in the evaporator were calculated by numerical integration of the mathematical model. The calculations indicated that the salt solution cannot be reconcentrated in a forced convection evaporator because of the large energy losses associated with the air stream passing through the evaporator.

54131 (PB—265489) **The potential economic impact of solar-heated residences in Illinois, 1976-2000.** Pogany, D.Z.; Dunwoody, J.E. (Illinois Dept. of Business and Economic Development, Springfield (USA). Div. of Energy). Sep 1976. 112p. (ILLDOE—77/02). NTIS, PC A06/MF A01.

This study examines the economic viability of solar heating systems for new residential construction in Illinois and accesses its potential economic and energy conserving impacts over the time frame of 1976-2000. Data on heating requirements, solar radiation and conventional energy costs for 6 Illinois cities is integrated into a 15 year life cycle cost analysis to determine the economic competitiveness of solar assisted systems as compared to convential heating systems. The study concludes with recommended research and policy action.

54132 (PB—266055) **Exploration of molecular-sieve zeolites for the cooling of buildings with solar energy. Final report 1 sep 74—31 Aug 75.** Tchernev, D.I. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1 Feb 1977. 99p. NTIS PCA05/MF A01.

Continuation of Grant NSF-AER74-09038.

The usefulness of molecular sieve zeolites for solar sorption heating and cooling has been investigated. Two different approaches have been used, one in which the temperature of the zeolite is uniform, the other in which a temperature gradient is established across the zeolite. With one-square-foot test panels using the uniform temperature approach, overall engineering efficiencies as high as 75% for heating with a condenser temperature of 60C (140F) were obtained. Cooling efficiencies as high as 45% were obtained for a condenser temperature of 50C (120F), the maximum temperature expected for an air-cooled condenser. With the temperature gradient approach, pressure differences up to 1.3 psi were obtained for

temperature differences of less than 100C across hot-pressed zeolite pellets as large as 2 inches in diameter. A demonstration module using the uniform temperature approach was constructed from nine one-square-foot panels and performed as expected from the panel test data. The results indicate that only 200 to 300 square feet of zeolite panels will be required for each ton of air conditioning capacity. According to preliminary estimates, the initial cost of combined zeolite systems for heating, cooling, and domestic hot water could be repaid in only 10 to 12 years, rather than the 25-30 years typically projected for solar systems providing heating only.

54133 Solar heating and cooling at New Mexico State University. San Martin, R.L. (New Mexico State Univ., Las Cruces). pp 27-39 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

The involvement of New Mexico State University in solar heating and cooling research is detailed. Various solar heating and cooling projects are described, and selected solar energy publications of the New Mexico State University are listed. (WHK)

WATER HEATING

REFER ALSO TO CITATION(S) 54133

HEAT ENGINES

REFER ALSO TO CITATION(S) 54112

54134 (SAND—77-0380) **Solar irrigation program. Status report, October 1976—January 1977.** Alvis, R.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). Apr 1977. Contract EY-76-C-04-0789. 64p. Dep. NTIS, PC A04/MF A01.

The status of the Solar Irrigation Program is summarized. The program initially consisted of a shallow well experiment that is now under construction in New Mexico. It has recently been expanded to include a deep well experiment in Arizona and a follow-on, as yet undefined, demonstration system. Most of this report is limited to technical discussions of the shallow well experiment design, and analyses are given which support the design choices selected.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 54115

54135 (COO/2446—8) **Non-imaging concentrators for wide angle collection of solar energy. II. Progress report, July 1, 1976—April 30, 1977.** Winston, R. (Chicago Univ., Ill. (USA). Enrico Fermi Inst.). Apr 1977. Contract EY-76-S-02-2446. 21p. Dep. NTIS, PC A02/MF A01.

Research at the University of Chicago on non-imaging concentrating collectors is briefly outlined. Activities in the design, construction, optical studies, and performance testing of concentrating collectors is reviewed. (WHK)

54136 (COO/2956—5) **Development of a freeze-tolerant solar water heater using crosslinked polyethylene as a material of construction. Progress report, January 5, 1977:—March 15, 1977.** Bradley, J.M. (Polyset, Inc., Manchester, Mass. (USA)). 1977. Contract EY-76-C-02-2956. 6p. Dep. NTIS, PC A02/MF A01.

Fifteen 10 ft coils of crosslinked tubing have been subjected to repeated freezing and thawing. The composition of the crosslinked polyethylene and the stress in the wall of the tubing (i.e., "hoop stress") are parameters which are being studied to find a crosslinked polyethylene composition which will be strong and resilient enough to withstand repeated freezing and thawing without necessitating excessively thick walls. The results are presented. The two XLPE formulations used in the coils appear sufficiently promising to be used in the construction of the collectors which will be performance tested at Los Alamos.

54137 (SAND—77-0111) **Semiannual review ERDA thermal power systems, dispersed power systems, distributed collectors, and research and development, mirror materials and selective coatings.** Pettit, R.B.; Butler, B.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1977. Contract EY-76-C-04-0789. 10p. Dep. NTIS, PC A04/MF A01.

The Solar Total Energy materials research and development efforts are divided into solar selective coatings, mirror materials, and reflector structures. Recent results in each of these areas are described.

54138 (UCRL—13722) **Generalized numerical model for predicting energy transfers and performance of large solar ponds.** Davis, B.W.; Day, J.A.; Iantuono, A. (Northern Arizona Univ., Flagstaff (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 May 1977. Contract W-7405-ENG-48;SUB-PO-115540. 28p. Dep. NTIS, PC A04/MF A01.

A highly generalized numerical model is being developed by members of the Mechanical Engineering Departments at Lawrence Livermore Laboratory and Northern Arizona University for predicting energy transfers and performance characteristics of large solar ponds. The code will be used to optimize the design and operation of a large solar pond which LLL and SOHIO Petroleum Company hope will provide a large part of the 750,000 gallons of 140°F water per day at a uranium milling facility in New Mexico. The code predicts that two inches of glass foam insulation will reduce the energy losses by more than 20% over the "no-insulation" condition. The code will also provide information about the energy delivered in response to a myriad of variations in the fill/empty cycle. Other information available from the code are the temperature response of the earth underneath the ponds at discrete points to a depth of 40 ft., the average instantaneous temperature response of the water during any day of the year, the individual loss components by radiation, convection, and conduction given instantaneously throughout any day of the year, the instantaneous values of loss coefficients during the day, and instantaneous values of efficiency during any day of the year. A brief discussion of extensions of the code is also presented.

54139 Solar collector with U-shaped absorber. Kersten, R. (to Philips Patentverwaltung G.m.b.H., Hamburg (Germany, F.R.)). German(FRG) Patent 2,523,965/A/. 2 Dec 1976. 16p. (In German).

The invention refers to a solar collector with a U-shaped tubular absorber which is sealed vacuum tight directly into a closed, evacuated, transparent covering tube, which is provided with an internal mirror surface along its whole length over a cross-section of at least 180°. The heat losses of the absorber can be reduced if the inside of the glass cylinder is covered with an infra-red reflecting layer. Apart from this, the absorber can be covered with a selective layer.

54140 Equipment for conversion of radiation energy, particularly of solar radiation, into electric power. von Hacht, G. German(FRG) Patent 2,525,630/A/. 30 Dec 1976. 13p. (In German).

An equipment for converting solar radiation into electric power is described. The solar radiation is concentrated by lenses, and is radiated in conically widening light conducting fibers on the inside of which, or in whose surrounding there are light-sensitive surfaces. Further it is possible to arrange the length of the fibers and to provide the ends of the fibers with reflecting mirror surfaces so that a laser effect occurs inside the fibers. This could lead to amplification of the light in the fibers.

54141 Equipment for increasing the efficiency of a CPC-solar energy collector. Chao, Bei Tse; Rabl, Ari. (to Energy Research and Development Administration, Washington, D.C. (USA)). German(FRG) Patent 2,628,557/A/. 13 Jan 1977. 13p. (In German).

The invention concerns a cylindrical reflector with concentrators, which concentrate the solar radiation on a small surface, in whose area the actual absorber is fitted. To improve the efficiency of the collector there is provision for using the solar energy absorbed by the reflecting walls. For this purpose conducting channels are fitted on the back of the reflectors, through which a heat transport medium flows and takes away the absorbed energy. This energy can be used directly or the channels can be connected in series with the main absorber.

54142 Experimental evaluation of a cylindrical parabolic solar collector. Ramsey, J.W.; Gupta, B.P.; Knowles, G.R. (Department of Mechanical Engineering, University of Minnesota, Minneapolis, Minn.). *J. Heat Transfer;* **99**: No. 2, 163-168(May 1977).

Results are presented for a series of solar collector experiments in which the incident solar flux was concentrated by a single-axis tracking parabolic trough mirror. The concentrated solar flux was directed onto an absorber tube whose axis coincided with the focal axis of the concentrator. The performance of the collector was evaluated using three different absorbers; a black painted tube designed to operate near ambient temperature, a heat pipe which had a selective solar absorber coating applied to its surface, and a heat pipe which had its surface coated with a nonselective black paint. The peak efficiency for the collector in the absence of heat losses is approximately 62 percent when the incoming solar energy is normal to the collector aperature. The heat losses which occurred at elevated temperatures (300degreeC) decreased the peak efficiencies to 50 and 30 percent, respectively, for the selectively coated and black painted tubes. The experimental results establish the technical feasibility of using parabolic trough collectors for applications requiring thermal energy at temperatures up to 300degreeC.

54143 Performance measurements of a cylindrical glass honeycomb solar collector compared with predictions. McMurrin, J.C.;

Djordjevic, N.A.; Buchberg, H. (Energy and Kinetics Department, School of Engineering and Applied Science, University of California, Los Angeles, Calif.). *J. Heat Transfer;* 99: No. 2, 169-173(May 1977).

A glass tube honeycomb solar collector, composed of a conventional single-glazed flat-plate water cooled nonselective black absorber with a cylindrical glass honeycomb mounted between the plate and cover glass, was designed, fabricated, and tested. The test procedure followed the National Bureau of Standards Method of Testing for Rating Solar Collectors. The honeycomb consists of individual cylindrical thin-wall glass tubes standing on end on the absorber plate in a hexagonal close-packed pattern. The tubes are 9.5-mm ID, 0.2-mm wall thickness, 5.3 length to diameter ratio made of glass with mean solar absorptive index (k-bar), 2.6 x 10^{-6} μ^{-1}, evaluated from spectral transmittance-reflectance measurements on a tubing specimen. The collector performance equalled or surpassed theoretical predictions for measurements made over a broad range of collector inlet temperatures and environmental conditions. Performance comparisons are made with a base-line double-glazed solar collector tested alongside the honeycomb collector. For applications requiring a working fluid temperature of 65degreeC above the ambient air temperature, honeycomb collector efficiencies of 35—55 percent may be expected for approximately a six hour period on clear days; for fluid temperature 40degreeC above ambient air temperature, efficiencies of 50—65 percent may be expected.

HEAT STORAGE AND REJECTION

REFER ALSO TO CITATION(S) 54095, 54113

GEOTHERMAL ENERGY

REFER ALSO TO CITATION(S) 54649

RESOURCE STATUS AND ASSESSMENT

NON-USA

54144 Present status of geothermal resources development. Fujiura, K. *Karyoku Genshiryoku Hatsuden;* 27: No. 4, 81-86(1976). (In Japanese).

The present status of geothermal energy development is described. The necessity of geothermal power development, the anticipated quantity of geothermal resources, and the status of geothermal development in Japan and other countries are covered. It is necessary to consider long term physical, chemical and geophysical investigations in the geothermal energy field as well as preservation of the natural environment and prevention of pollution. At the present time investigations are underway in the fields of electrical power generation, hot water utilization, and techniques for energy extraction in hot dry rock areas.

54145 Future of the utilization of geothermal energy. Hayakawa, M. (Tokai Univ., Oceanography Dept., Japan). *Saiensu;* 63-65(Aug 1976). (In Japanese).

Special issue.

The estimated heat energy which actually flows out of Japanese geothermal areas amounts to 5 x 10^{18} erg/yr, equivalent to mechanical energy of 2 x 10^{24} erg/yr. This does not include the energy of active volcanoes. If power generation efficiency is taken into account it should be possible to convert this energy into two terawatts of electrical power. This power could be generated continuously if the amount of rainfall, geothermal energy, rock porosity and infiltration capacity are maintained constant. The geothermal electrical power capacity of Japan is presently limited but as technology advances it is realistic to state that the capacity will reach from 100,000 W to several gigawatts.

54146 Studies on the energy system of Hokkaido. I. Hasegawa, J.; Nishiya, K.; Murai, K.; Satoh, Y. *Mem. Fac. Eng., Hokkaido Univ.;* No. 83, 89-99(1977). (In Japanese).

The importance of the energy shortage facing the world has been recognized and discussions have been carried out on the local to international level. Due to the complexity of the matter a systems approach to the subject is required. Work has been done on the energy system of Hokkaido, Japan, and a modeling system is presented. The model was constructed for analysis of the current situation and for the optimization of Hokkaido's energy system. It is a static, linear programming model which ignores dynamic behaviour. It includes 192 variables, 46 equality constraints, and has a density of about 6%. The effects of other energy systems, environmental systems and social systems are dealt with exogenously.

54147 Studies on the energy system of Hokkaido. II. Various data and their basis. Hasegawa, J.; Nishiya, K.; Murai, K.; Satoh, Y. *Mem. Fac. Eng., Hokkaido Univ.;* No. 83, 101-111(1977). (In Japanese).

An energy system model was developed for Hokkaido. The various data required for analysis are discussed. Included are the supplies and demands of each energy source, end uses and the efficiencies of conversion. The efficiency of consumption by end users is determined or assumed as are the costs of air pollution resulting from energy conversion, transmission, distribution and utilization.

54148 Studies on the energy system of Hokkaido. III. Simulations by model I. Hasegawa, J.; Nishiya, K.; Murai, K.; Satoh, Y. *Mem. Fac. Eng., Hokkaido Univ.;* No. 83, 114-122(1977). (In Japanese).

This is the third of a series of articles concerning a model which was developed to simulate the energy system of Hokkaido. The results of simulations are described. Although detailed numerical values in the results and conclusions did not always coincide with reality, the tendencies of the results are considered valid, as are the conclusions and their implications. Both the model and the nature of the input will be refined in order to develop a more reliable and detailed analysis of the energy system of Hokkaido.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

USA

54149 (VPI-SU—5103-3) Evaluation and targeting of geothermal energy resources in the southeastern United States. Progress report, November 1, 1976—March 31, 1977. Costain, J.K.; Glover, L. III; Sinha, A.K. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). 1977. Contract EY-76-S-05-5103. 155p. Dep. NTIS, PC A08/MF A01.

The objective of this research is to develop and apply targeting procedures for the evaluation of low-temperature radiogenically-derived geothermal resources in the eastern United States utilizing geological, geochemical, and geophysical data. Detailed study of the Liberty Hill and Winnsboro plutons, South Carolina, is continuing in order to provide insight into the behavior of uranium and thorium in unmetamorphosed granitic plutons during periods of crystallization, deuteric alteration and weathering. The importance of the oxidation state of uranium has become apparent because the transition from U^{4+} to U^{6+} represents the division between immobile and labile uranium. Accessory uraninite has been found in the Liberty Hill pluton, and molybdenite mineralization occurs in both the Liberty Hill and Winnsboro plutons. The molybdenum mineralization is present in a number of 300 m.y. granitic plutons in the southeastern U.S. A steep metamorphic gradient across the Roxboro, North Carolina, metagranite, which was metamorphosed during Devonian time, should provide a good opportunity to study the effect of prograde metamorphism on the distribution of uranium and thorium. Three holes have been drilled into the Roxboro metagranite for the purpose of examining the effect of metamorphism on heat generation and heat flow. Preliminary modeling of negative gravity anomalies in the Coastal Plain supports the interpretation of a deep granitic pluton near Norfolk, Virginia, and probably at Georgetown, South Carolina.

NON-USA

54150 Hydrogeologic studies on the hot springs in Kagoshima city, South Kyushu, Japan. Tsuyuki, T. (Inst. of Earth Sci., Fac. of Sci., Kagoshima Univ., Japan). *Kagoshima Daigaku Rigakubu Kiyo;* No. 8, 63-77(1975). (In Japanese).

Hydrogeologic studies on the hot springs in Kagoshima City, Japan, were performed using available geologic information and chemical analyses of water from drilled wells. More than 90 wells have been drilled for thermal water since 1950. They range in depth from 400-800 meters. The basement geology in the area is the Shimanto Formation, composed of sandstone and shale of Cretaceous to Tertiary age. The Shimanto is overlain by the Kekura (Quaternary). An alluvial aquifer carrying fresh water overlies the older rocks. The thermal waters of the area fall into three classifications. A-type is alkaline spring water with a concentration of dissolved solids less than 1 g/kg. It is found in both the Shimanto and Kekura formations. B-type water is saline, ranging from 5/22 g/kg dissolved solids. It is found in the Kekura and Terukuni welded tuff. It is assumed to derive from ancient sea waters held in marine formations. These waters are believed to have migrated to their present locations through gently dipping aquifers. C-type waters are characterized by the presence of chlorides and bicarbonates with dissolved solid concentrations ranging from 1-5 g/kg. It is found in both the Shimanto and Kekura formations over a broad geographic area. The relation between the A and C-types of water is not clear. It

is believed that it is partially due to ancient thermal activities and partially as a result of the mixing of A-type and B-type waters during the migration of the older sea water.

54151 Conceptual pattern to the complex investigation of the underground waters thermalization in the western plain of Romania. Airinei, S. (Univ. of Bucharest); Pricajan, A. *Rev. Roum. Geol., Geophys. Geogr., Ser. Geol.;* **20**: 109-119(1976).

A conceptual model for the investigation of geothermal processes in the western plain of Romania (located on the eastern flank of the Pannonian Depression) was developed. The model requires the integration of diverse geological and geophysical data. It is believed that anomalies in the surface heat flux result primarily from the concentration of thermal waters in reservoirs provided by structural weakening of the crustal rocks. The precise mechanisms of hydrothermality probably arise as a result of a complex of factors including waters rising from subterranean heat sources and meteoric waters heated by shallow radioactive processes. Although the heat flux anomalies provide excellent information on the presence of geothermal resources it is believed that further research is necessary to clarify the mechanisms of heat production.

54152 Heat transfer in hot springs area. Urakami, K. (Fac. of Engg., Hokkaido Univ.). *Hokkaido Daigaku Chikyu-Butsurigaku Kenkyu Hokoku;* **35**: 15-32(Jun 1976). (In Japanese).

A numerical method was devised for the solution of steady-state heat transfer equations. A simulation of a generalized model of confined aquifer hot springs and a numerical model of the hot water flow system at Tendo hot springs were performed. Results showed that hot water flow directly affects temperature distribution in an aquifer. Total heat energy discharged as hot water from the area increases in proportion to hot water discharge until the discharge reaches a certain limit. Beyond that limit heat energy discharge decreases with increasing water discharge due to cold groundwater mixing. This relation can be used to estimate the maximum discharge from hot springs. The Tendo system was simulated using geologic and hydrologic data. By comparing observed temperature with calculated temperature the quantity of hot water supply was estimated at 800 liters/min.

54153 Geothermal measurements in Paleogene, Cretaceous and Permo-Carbonlferous sediments in northern Bohemia. Cermak, V. (Geophys. Inst., Czechoslovak Acad. of Sci.). *Geophys. J. R. Astron. Soc.;* **48**: No. 3, 537-541(Mar 1977).

Heat flow studies in northern Bohemia have yielded values in the range of 60 to 80 mW/cm. These data are compatible with the results of earlier heat flow studies in this region. The area is a large sedimentary basin and represents a zone of relatively weak crust in the north-eastern sector of the Bohemian Massif. The new data derived support generally higher geothermal activity in the Cretaceous basin as compared with the stable central block of the Bohemian Massif.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOPHYSICAL TECHNIQUES AND SURVEYS

54154 (E—77--10126) **Application of remote sensor data to geologic analysis of the Bonanza test site, Colorado. Final report.** Lee, K. (Colorado School of Mines, Golden (USA). Dept. of Geology). Dec 1976. 43p. NTIS, PC A03/MF A01.

The following significant results. The Hayden Pass (Orient mine area) includes 60 sq miles of the northern Sangre de Cristo Mountains and San Luis Valley in south-central Colorado. Based on interpretation of the remote sensor data, a geologic map was prepared and compared with a second geologic map, prepared from interpretation of both remote sensor data and field data. Comparison of the two maps gives an indication of the usefulness and reliability of the remote sensor data. The relative utility of color and color infrared photography was tested. The photography was used successfully to locate 75% of all faults in a portion of the geologically complex Bonanza volcanic center and to map and correctly identify 93% of all quaternary deposits and 62% of all areas of tertiary volcanic outcrop. Using a filter wheel photometer, more than 8,600 measurements of band reflectance of several sedimentary rocks were performed. The following conclusions were drawn: (1) the typical spectral reflectance curve shows a gradual increase with increasing wavelength; (2) the average band reflectance is about 0.20; and (3) within a formation, the minimum natural variation is about 0.04, or about 20% of the mean band reflectance.

54155 Heat flow map of the Bohemian massif. Cermak, V. (Geophys. Inst., CS Acad. of Sci.). *J. Geophys.;* **42**: No. 5, 455-458(1977).

Forty seven heat flow values for the Bohemian massif were used to determine the heat flow pattern of the area. By including data from neighboring countries it was possible to draw an isothermal map outlining the geothermal activity. As a result, it is possible to closely correlate the heat flow and the tectonic structure. It is obvious that the areas of high geothermal activity correspond to zones of crustal weakness associated with two major faults bordering the rigid central section of the massif. The highest heat flow values coincide with the axis of the sedimentary basin. The development of these heat flow patterns should assist in the recognition of probable areas of geothermal resources and several promising sites are readily discernible.

54156 Heat production data from airborne and laboratory measurements of gamma-ray activity of rocks. Cermak, V. (Geophys., CS Acad. of Sci., Prague); Vankova, V.; Matolin, M.; Bartosek, J. *Stud. Geophys. Geod.;* **21**: No. 1, 70-80(1977).

The relationship between heat production due to radioactive decay and laboratory determinations of total gamma-ray activity expressed in equilibrium uranium concentration is discussed. The concentrations of U, Th and K were determined spectrometrically and conversion factors for the rate of heat generation were applied to yield heat production data. The relations obtained should be of assistance in defining the contribution of surface rock heat production to the figures obtained during heat flow studies. There was an experimental relation between gamma-ray activity determined by aeroradiometry and the laboratory measurement of rock samples. This relation should be valuable in estimating surface heat production in a given locality. The relations have already been applied with good results in several localities and will be applied to determination of heat flow in the Bohemian Massif and the western Carpathians. Data are presented in tabular form and a map of areas studied is provided.

GEOCHEMICAL TECHNIQUES AND SURVEYS

54157 Geothermometric determination of the maximum temperatures of the hydrothermal zones of Languedoc-Roussillon and the Pyrenees-Orientales. Avias, J.; Passavy, J.; Valat, J.L. *C. R. Hebd. Seances Acad. Sci., Ser. D;* **284D**: No. 12, 1025-1027(21 Mar 1977). (In French).

After an exploratory survey of the thermal springs of Languedoc-Roussillon, it was determined that there are six primary areas which demonstrate positive geothermal anomalies. In order to determine the subsurface water temperatures the SiO_2 and the Fournier/Truesdell Na-K-Ca geothermometers were applied. The results and the validity limits of these determinations are discussed and a map of the temperature distributions is provided.

EXPLORATORY DRILLING AND WELL LOGGING

REFER ALSO TO CITATION(S) 55053

54158 (LA-UR—77-574) **Thermopile probe to measure temperature anomalies in geothermal boreholes.** Dennis, B.R.; Stephani, E.L.; Todd, B.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 17p. (CONF-770418—3). Dep. NTIS, PC A02/MF A01.

From 9. transducer workshop of the Range Commanders Council; Fort Walton Beach, Florida, United States of America (USA) (26 Apr 1977).

The standard thermal well logging tools presently employed by oil well logging service companies use a thermistor probe as the temperature measuring device. The thermistor is normally incorporated as one arm of a Wheatstone bridge circuit. The bridge circuit must be staged for limited temperature ranges and is adequate for most well logging operations where only detection of thermal anomalies is of primary concern and the logging speed is not important. The design of a thermopile sensor using conventional thermocouples and a downhole thermally isolated reference junction has greatly improved the temperature logging capability in a deep geothermal wellbore. The much faster response of the thermopile sensor will allow a logging rate of up to 200 ft/min in contrast to the average rate of 50 ft/min using the thermistor probe. The thermopile sensor is a low impedance device whose characteristics are very well known. The development of a high pressure dewar chamber for use in high temperature downhole instrumentation sondes has provided a suitable environment to employ a downhole reference junction permitting the use of thermocouple measurements in the deep geothermal borehole.

LEGAL AND INSTITUTIONAL ASPECTS

54159 Geothermal development in California will come under scrutiny in two studies. *Chem. Eng. (N.Y.);* **83**: No. 14, 34(5 Jul 1976).

The draft of the Battelle Memorial Institute, Pacific Northwest Laboratories study, to be released after review in late August 1976, finds the major roadblocks to be the utilities, aversion to

technological risks and a foggy regulatory climate. The study discusses legal, institutional, and political problems. It was performed under contract to E.R.D.A., the Federal Energy Administration and the EPA. A second study, by the Jet Propulsion Laboratory under sponsorship of E.R.D.A. and the California Energy Resources Conservation and Development Commission, will determine what kind of Federal, State, and local actions are needed to assist local authorities in developing the State's geothermal resources. This study is one of four E.R.D.A. regional investigations; the others are to cover the northwest, southwest, and Texas-Louisiana areas.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 53707

54160 (UCID—17459(Rev.1)) **Climatology of air quality of Long Valley Geothermal Resource Area.** Peterson, K.R.; Palmer, T.Y. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1977. Contract W-7405-ENG-48. 117p. Dep. NTIS, PC A06/MF A01.

The Long Valley Known Geothermal Resource Area is one of the more promising regions for development of a large-scale geothermal energy center. This report discusses the climatology and air quality of the area. Details are given on the temperatures, temperature inversions, and winds. Estimates are presented for the present air quality and future air quality during and following development of the resource area. Also discussed are project impact from added pollutants, noise, and precipitation augmentation. The major deleterious effects from development of the Long Valley Geothermal Resource Area appear to be due to increased dust loading during and following construction, and noise from production testing and potential well blowouts. Increased pollution from release of hydrogen sulfide and other pollutants associated with hot water geothermal wells seems to present no problems with regard to surrounding vegetation, potential contamination of Lake Crowley, and odor problems in nearby communities. Precipitation augmentation will probably increase the water level of Lake Crowley, at the expense of possible additional fogging and icing of nearby highways.

54161 **Effects of the 1974 Izu earthquake on hot spring qualities.** Sugiura, T.; Hamasuna, T.; Mizutani, Y. *Aichi Kyoiku Daigaku Kenkyu Hokoku, Shizen Kagaku;* 25: No. 2, 33-38(1976). (In Japanese).

Studies were made of the effects of the 1974 offshore Izu earthquake on the qualities of neighboring hot springs. These correlations are important as the activity and nature of hot springs are highly dependent on geological structure. In this case, the magnitude of the earthquake was 6.9. It occurred at a depth of 10 km at the location 34°34'N and 138°45'E. Numerous hot springs were sampled both in November 1973 and June 1974, thus providing pre- and post-earthquake data. The samples were analyzed for cations Na, K, Li, Ca, Mg, Mn and anions Cl, Br, SO_4 and the SiO_2 concentration. The concentrations of these species were found to change markedly after the earthquake and in some cases the change could be correlated with change in the flow rate of the springs.

54162 **Problems of environment in geothermal power generation.** Saito, M. (Union Consultant Co., Japan). *Hatsuden Suiryoku;* No. 146, 31-35(1977). (In Japanese).

In Japan, the hot water produced by geothermal fields contains arsenic. The primary geothermal fields of Otake, Onuma, Kuzuneda, Onikubi, and Hatchobara produce enormous quantities of waste water. This waste is disposed of by reinjection into subterranean strata. Although this method of disposal prevents the addition of arsenic to the biosphere and helps to maintain production of hot water and steam, it is feared that the reinjection may lead to increased earthquake activity. The hot springs at Matsukawa and Tamagawa both produce abundant arsenic and H_2S. Although this discharge has not had any detectable environmental effects there is concern over the long term impact of the noxious by-products of geothermal power generation. In order to avert future problems in this sphere it will be necessary to continue the current vigilant attitude toward environmental effects. Ten references are given.

GEOTHERMAL POWER PLANTS

54163 (COO—4051-4) **Minutes: fourth meeting of the centers for the analysis of thermal/mechanical energy conversion concepts. Report No. CATMEC/3.** DiPippo, R. (Brown Univ., Providence, R.I. (USA). Div. of Engineering). 1977. Contract EY-76-S-02-4051. 183p. (CONF-770113—). Dep. NTIS, PC A09/MF A01.

From 4. meeting of the centers for the analysis of thermal/mechanical energy conversion concepts; Berkeley, California, United States of America (USA) (24 Jan 1977).

The agenda, executive summary, approved minutes, list of participants, and appendices are included. Separate abstracts were prepared for five papers. (MHR)

54164 **Outline of public works in construction of Onigashira geothermal power plant.** Kasoku, T. (Electric Power Dev. Co., Japan). *Kensetsu No Kikaika;* No. 325, 34-41(1977). (In Japanese).

After ten years of surveys and geological studies it was decided to situate a new geothermal power plant in the Onigashira geothermal field. The new plant has a generating capacity of 25 MW, making it the fourth largest in Japan. Construction began in April of 1973 and the plant was brought partially on line in March of 1975. The field is characterized by sedimentary beds to almost 8 m depth, underlain by an argillized zone composed of heat altered tuff and tuff breccia. A bearing layer with N values in excess of 30 is located at depths of greater than 20 m. The temperature of the bearing layer is about 50°C and the soil pH is around 4.0. The field possesses many fumaroles and mud volcanoes which produce H_2S, water and steam. As the H_2S concentration ranges from 0.01 to 0.3 ppm, a great deal of research on anti-corrosive construction materials was required. Maps of the area, geological sections and tables of chemical characteristics are provided.

DESIGN AND OPERATION

54165 (COO—4051-4, pp 32p., App. C) **Cost optimization studies of geothermal cycles: a proposal.** Pope, W.L.; Green, M.A.; Pines, H.S.; Williams, J.D. 1977.

From 4. meeting of the centers for the analysis of thermal/mechanical energy conversion concepts; Berkeley, California, United States of America (USA) (24 Jan 1977).

In Minutes: fourth meeting of the centers for the analysis of thermal/mechanical energy conversion concepts.

A list of geothermal processes (cycles and working fluids) which could be optimized with the LBL program GEOTHM is proposed. The objective of these studies would be to determine the general influence of major process variables on the mutual interaction of the (1) energy cost, (2) resource utilization efficiency, and (3) resource temperature for selected ideal geothermal cycles for assumed resource conditions, subsystem costs and efficiencies, and working fluids. Results of these studies would by 3-dimensional isometric computer plots of the energy cost-resource utilization efficiency-resource temperature surface for each case studied. In addition, tabulated results will be presented for each fluid illustrating the detailed thermodynamic and cost break-down of the entire plant for a minimum energy cost set of design conditions at up to 5 resource temperatures. (MHR)

54166 (COO—4051-4, pp 17p., App. D) **Cycle studies at LBL using program GEOTHM.** Pope, W.L.; Pines, H.S.; Green, M.A.; Williams, J.D. 1977.

From 4. meeting of the centers for the analysis of thermal/mechanical energy conversion concepts; Berkeley, California, United States of America (USA) (24 Jan 1977).

In Minutes: fourth meeting of the centers for the analysis of thermal/mechanical energy conversion concepts.

The GEOTHM code structure and development and some of the studies conducted with GEOTHM are described. Thermodynamic cycle optimization is discussed in both the passive and the dynamic design mode. (MHR)

54167 (COO—4051-4, pp 3p., App. H) **Energy conversion standards.** DiPippo, R.; Kestin, J.; Khalifa, H.E. 1977.

From 4. meeting of the centers for the analysis of thermal/mechanical energy conversion concepts; Berkeley, California, United States of America (USA) (24 Jan 1977).

In Minutes: fourth meeting of the centers for the analysis of thermal/mechanical energy conversion concepts.

A revised set of energy conversion standards were presented incorporating the suggestions of the group. Included are: wellhead conditions, ambient conditions, heat exchanger pinch point, turbine efficiency, pump efficiency, and system performance factors. (MHR)

54168 (IDO/1549—5) **Analysis of direct contact binary cycles for geothermal power generation (program DIRGEO).** Riemer, D.H.; Jacobs, H.R.; Boehm, R.F. (Utah Univ., Salt Lake City (USA). Dept. of Mechanical Engineering). Sep 1976. Contract EY-76-S-07-1549. 117p. Dep. NTIS, PC A06/MF A01.

Thesis. Submitted by D.H. Riemer.

A computer program was produced which would analyze a direct-contact binary fluid power plant as conceived for geothermal applications. The current cycle consists of a direct-contact boiler, binary vapor mixture turbine, parallel flow liquid-liquid preheaters, pumps, flash expander and a condenser. The program computes important design parameters which allow the user to select the optimum operating condition for a particular well. The program allows for the evaluation of cycles utilizing liquid hydrocarbons and fluorocarbons as secondary fluids. A complete description of the executive program including flow charts, program listings and vari-

able symbol tables is contained. A sample run of the main program completes the description of its use.

54169 (LBL—6303) **Thermodynamic and cost optimization using program GEOTHM.** Green, M.A.; Pines, H.A.; Pope, W.L.; Williams, J.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1977. Contract W-7405-ENG-48. 6p. (CONF-770569—1). Dep. NTIS, PC A02/MF A01.

From Geothermal Resources Council; San Diego, California, United States of America (USA) (9 May 1977).

Some of the features of the computer program GEOTHM are shown. This program designs and optimizes thermodynamic process cycles. Several examples of geothermal cycle optimization are given. Three dimensional plots generated by the computer show how the optimization process works.

54170 (ORO—4944-5) **Resource utilization efficiency improvement of geothermal binary cycles, phase II. Semiannual report, June 15, 1976—December 15, 1976.** Starling, K.E.; Fish, L.W.; West, H.; Johnson, D.W.; Iqbal, K.Z.; Lee, C.O. (Oklahoma Univ., Norman (USA). School of Chemical Engineering and Materials Science). 1976. Contract EY-76-S-05-4944. 59p. Dep. NTIS, PC A04/MF A01.

The following elements of research were performed: (1) upgrading of the conventional geothermal binary cycle simulation computer program, (2) development of a preliminary version of a direct contact heat exchanger algorithm, (3) comparison studies of mixture and pure fluid cycles, including relative equipment sizing and economics, (4) sensitivity analysis of brine cost, heat exchanger cost, operating conditions and working fluid composition on total geothermal power system cost, and (5) the development of a parameter optimization algorithm to aid cycle evaluation studies.

54171 Freon powerplant with heat supply at the expense of cooling of a source. *Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Tekh. Nauk;* No. 3, 140-144(1973). (In Russian).

Geothermal resources can be used for generating electrical energy. The Freon multistage cycle was investigated as an approach to thermodynamic efficiency of a reversible triangular cycle. Optimal temperature distribution of the cycle was determined. By using water at 100°C and a cooling basin at 5°C, heat can be utilized for conversion into electrical energy within 60 percent of a steam-vacuum plant. By combining geothermal, steam, and three-stage Freon plants, heat losses were approximately 40 percent of those of a steam plant.

54172 Device for converting internal energy of hot fluids to shaft work. Wahl, E.F. III. (to Occidental Petroleum Corp.). US Patent 4,027,483. 7 Jun 1977. Filed date 18 Aug 1975. 14p.

The apparatus to convert the internal energy of hot fluids to mechanical work comprises a pair of nozzles, e.g. convergent-divergent nozzles, mounted oppositely on hollow support arms which are in turn mounted on a rotating hollow shaft which is coupled to a conventional electric generator or other device requiring mechanical power. The hot liquid, e.g., hot brine, flows through the hollow shaft and the hollow support arms to the nozzles, where the hot fluid expands and creates a thrust and torque on the shaft, causing it to rotate and create shaft power. The nozzles and rotating shaft are mounted in a closed container from which the exhaust fluid, gases and liquid are removed by conventional means so as to maintain a reduced pressure within the container.

POWER PLANT SYSTEMS AND COMPONENTS

REFER ALSO TO CITATION(S) 54186

54173 (COO—4051-4, pp 13p., App. J) **Section index. Flash steam power cycles.** 1977.

In Minutes: fourth meeting of the centers for the analysis of thermal/mechanical energy conversion concepts.

The following subjects are covered: gathering of geothermal water from hot water wells, selection of optimum conditions for flash steam production, selection of optimum conditions for steam turbine exhaust pressure and turbine exhaust heat sink, selection of equipment for removal of noncondensable gases from steam turbine exhaust, disposal of noncondensable gas from flash steam power cycles, disposal of waste heat and water from flash steam separation system, materials of construction for flash steam power cycle equipment, and operation and safety considerations for flash steam power cycles. (MHR)

54174 (IDO/1523—2) **Heat transfer characteristics of a surface type direct contact boiler.** Deeds, R.S.; Jacobs, H.R.; Boehm, R.F. (Utah Univ., Salt Lake City (USA). Dept. of Mechanical Engineering). Mar 1976. Contract EY-76-S-07-1523. 87p. Dep. NTIS, PC A05/MF A01.

Thesis.

Two direct contact heat exchangers were constructed and test results were obtained using water and refrigerant 113 as the working fluids. The heat exchangers were operated in a three-phase mode; the water remained liquid throughout the vessel and the liquid refrigerant 113 underwent vaporization following direct injection into the water. The effect of important operational parameters—operating heights, refrigerant 113 injection techniques, mass flow ratios, and temperatures—was studied to determine generalized trends important in the design and operation of a prototype three-phase direct contact heat exchanger. The primary system used in this study performed well overall. The initial favorable results of this study warrant further investigation of direct contact heat exchange as a means of utilizing geothermal energy.

54175 (IDO/1523—3) **Direct contact condensers: a literature survey.** Jacobs, H.R.; Fannar, H. (Utah Univ., Salt Lake City (USA). Dept. of Mechanical Engineering). Feb 1977. Contract EY-76-S-07-1523. 29p. Dep. NTIS, PC A03/MF A01.

A review is given of the literature pertinent to the design of direct contact condensers using water to condense an organic fluid. Both overall performance and fundamental concepts are examined. Recommendations are made regarding the work required to evaluate this concept for use in binary cycles for geothermal power plants.

54176 (IDO/1549—6) **Solubility of selected secondary fluids for use in direct contact geothermal power cycles.** Hellstrom, G.W.; Jacobs, H.R.; Boehm, R.F. (Utah Univ., Salt Lake City (USA). Dept. of Mechanical Engineering). Dec 1976. Contract EY-76-S-07-1549. 85p. Dep. NTIS, PC A05/MF A01.

Thesis. Submitted by G.W. Hellstrom.

The use of a direct contact binary power cycle, in connection with a geothermal resource, makes it necessary to consider the solubility of the secondary fluid within the geothermal brine, at the outlet of the power plant. Four possible fluids for use in a direct contact binary cycle were considered. They were: pentane, isobutane, R-113 (trichloro-trifluoro ethane), and R-114 (dichloro-tetra-fluoro ethane). The solubility was determined, using gas chromatography, for the temperature range 25 to 95°C and also for sodium chloride concentrations ranging from 0 to 25 weight percent. The solubilities of these four fluids were compared as a function of various binary cycle parameters. It was found that isobutane has the lowest absolute solubility, if all the fluids are at the same pressure. Pentane is only slightly more soluble than isobutane, for the same pressure. It was found that pentane is less soluble than the other three fluids, if all four fluids are allowed to expand to their partial pressure for a given temperature. It was also found that pentane was the least expensive of the four fluids to operate at a given condenser temperature and brine outlet temperature.

54177 (IDO/1549—7) **Analysis of binary vapor turbines.** Bliss, R.W.; Boehm, R.F.; Jacobs, H.R. (Utah Univ., Salt Lake City (USA). Dept. of Mechanical Engineering). Dec 1976. Contract EY-76-S-07-1549. 194p. Dep. NTIS, PC A09/MF A01.

Thesis. Submitted by R.W. Bliss.

The effect the binary mixture has on the turbine is examined in terms of design and cost. Several flow theories for turbines and turbine blading are reviewed. The similarity method, which uses dimensionless parameters, is used in determining rotative speeds and diameters for a variety of inlet temperatures and exit pressures. It is shown that the ratio of exit to inlet specific volume for each component in the mixture is the same for each specie. The specific volume ratio constraints are combined with the temperature equalities, the condenser pressure, and the total inlet entropy to form the constraints necessary to determine the exit state uniquely in an isentropic expansion. The non-isentropic exit state is found in a similar manner. The expansion process is examined for several cases and compared with the expansion of a single component vapor. Finally, in order to maintain high efficiency and to meet the criteria which makes the similarity method valid at high inlet temperatures, turbine multistaging is examined and a sample case is given for a two stage turbine.

54178 Rotary separator/turbine handles geothermal brines. Stengel, R.F. *Des. News;* 33: No. 9, 40-41(2 May 1977).

The product of most geothermal fields is a pressurized hot water with high mineral content rather than dry steam. As only a small quantity of the fluid is flashed to steam the development of devices which can effectively utilize the two-phase product is desirable. A device patented in 1975 combines aspects of centrifugal separators and turbines. Brine is expanded through nozzles tangential to the rotating components and partially flashed to steam which accelerates the remaining liquid. At the nozzle exit the fluid enters a rotating separator drum where it separates into a liquid ring and vapor core. This is accomplished with minimal friction losses. Finally the liquid is fed through a radial inflow turbine and the vapor is ducted to a heat exchanger. The condensor output is potable and may be used for municipal supply or irrigation. Biphase Engines Inc. has built a test unit which is truck mounted for field testing. It is expected that the system is capable of producing 1.1 MW and 866,250 liters/day of fresh water, given a wellhead pressure of 1.5 MN/cm^2 (225 psi).

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

54179 Drilling practice in the geothermal area of the northern Kurikoma district. Takahara, M. *Kozan Chishitsu;* No. 25, 155-160(1975). (In Japanese).

The Kurikoma district is located in the volcanic region of the northeastern part of Japan and is well known as a hot spring area. Dowa Mining Co., Ltd. organized an exploration team for the area in 1972. Geological and geophysical surveys were made and five boreholes were sunk by the end of 1974. The particular drilling techniques chosen for the area are described and are compared to conventional methods used in the exploration of suspected mineral deposits.

54180 (SAN/1140—1/1) Planning and design of additional East Mesa Geothermal Test Facilities. Phase 1B. Volume I. Final report. Pearson, R.O. (TRW Defense and Space Systems Group, Redondo Beach, Calif. (USA). Systems Engineering and Integration Div.). Oct 1976. Contract EY-76-C-03-1140. 91p. Dep. NTIS, PC A05/MF A01.

The planning and design of additions to the ERDA East Mesa Geothermal Component Test Facility are discussed. The ERDA East Mesa Geothermal Component Test Facility will provide moderate temperature/low salinity fluids to facilitate comprehensive testing of conversion systems and components under realistic field conditions. The project objectives included development of designs of new wells and modifications to existing wells to improve definitive reservoir evaluations and design of additional test facilities integrated with the limited-scale facilities to accommodate diverse commercial utilization technology experiments. A reservoir utilization evaluation was conducted to establish locations and design drilling programs for three new wells and modifications to existing wells to improve reservoir definition and provide a comprehensive inventory of geothermal well fluids for testing. Ten test facility additions were developed as individual procurement packages of specifications and drawings to facilitate near term construction activation.

54181 Problems of geothermal well completion. Shinoyama, S.; Nakamura, S. *Sekiyu Gijutsu Kyokaishi;* **41**: No. 3, 26-32(May 1976). (In Japanese).

The problems encountered during the drilling of geothermal wells and some solutions to those problems are described. Temperature conditions and casing programs are discussed. Particular attention is given to problems arising from incomplete cementation, corrosion, erosion, high temperatures and accidental mechanical failures. The procedures of full-wall cementing are covered and it is recommended that a higher strength cement than actually required be used whenever possible. Further research on geothermal well cements is deemed necessary.

54182 Problems in drilling techniques for high temperature strata. Tanaka, S. *Sekiyu Gijutsu Kyokaishi;* **41**: No. 5, 1-3(Sep 1976). (In Japanese).

The characteristic geology of geothermal areas is described and the problems commonly encountered in drilling these areas is discussed. Geothermal resources are classified in three categories: thermal convective; abnormal high pressure; and hot rock/magma. The steam fields of Matsukawa and the Geysers, and the hot water fields of Otake and Hachimandaira are classified as thermal convective systems. The typical drilling problems discussed include water leakage, drilling mud breakdown, cement failure, and environmental hazards. Special drilling techniques such as air drilling are reviewed.

54183 Drilling of Onuma geothermal wells: especially well 0-3Rb. Yora, M.; Kubota, Y.; Matsuo, K.; Nakamura, S. *Sekiyu Gijutsu Kyokaishi;* **41**: No. 5, 13-19(Sep 1976). (In Japanese).

At the Yawatadaira geothermal power plant 7.5 MW of electricity are generated by 78 t/h of steam from the steam wells. The electricity produced is consumed in its entirety by the local zinc industry. Four exploratory wells and four producing wells were completed in 1968. The drilling of well 0-3Rb, which encountered more problems than the other wells, is described in detail. The primary problems encountered were the presence of extremely hard rock strata near the surface, and the loss of drilling mud. The well was drilled vertically to a depth of 1260 m. As the amount of steam produced was quite small an inclined secondary bore was made beginning at 651 m and continuing to 1527 m. Geological structural sections and a summary of internal temperature distributions are provided.

FLUID TRANSMISSION

54184 (UCRL—79043) Computation of gas-liquid equilibria in high-saline geothermal fluids. Jackson, D.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Apr 1977. Contract W-7405-ENG-48. 11p. (CONF-770609—3). Dep. NTIS, PC A02/MF A01.

From SPE international symposium on oilfield and geothermal chemistry; San Diego, California, United States of America (USA) (27 Jun 1977).

A computer-assisted chemical modeling study of equilibria in flowing brine systems has been undertaken. Equilibria between liquid and volatile components of two-phase fluids have profound effects on such important phenomena as corrosion, scale formation, environmental quality, and the economics of energy extraction. The principal reactions considered are those involving volatiles naturally present in the fluid, including NH_3, H_2S and CO_2. A computer code is described which performs stepwise equilibrium computations at 1°C intervals for a unit mass of fluid, between reservoir and reinjection temperatures. The data base used is the quality-temperature function for the brine, the chemical composition, and equilibrium constants for the solubility reactions of gases and dissociation of their aqueous species. Chemical changes that take place during cooling and expansion are illustrated by distribution diagrams. Although the computations were developed for application to the high-saline resource, they are not fluid or system-specific, and should be of general usefulness where a chemical composition and temperature history can be specified.

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

REFER ALSO TO CITATION(S) 54823

54185 (ORNL/TM—5959) Precipitation and scaling in dynamic geothermal systems. Progress report ending December 31, 1976. Bohlmann, E.G.; Shor, A.J.; Berlinski, P. (Oak Ridge National Lab., Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 52p. Dep. NTIS, PC A04/MF A01.

Major additions and modifications to a titanium loop system for conversion to the study of the formation of silica from simulated geothermal brine were completed. Preliminary pressure and temperature testing with water up to 1000 psig and 200°C, respectively, indicated general operability of the system. A 0.5- to 1.5-gpm sidestream was monitored and cooled under controlled conditions from 190°C to 50°C in a five-section double-tube bypass heat exchanger, then reheated and recycled. Satisfactory performance of the saturator column in providing suitable silica containing brines was also demonstrated. An on-line programmable computer-based data acquisition system was connected to the loop system to read temperature and flow data; to estimate heat transfer coefficients; and to perform additional monitoring, such as limit control and safety functions. Studies with the Once-Through System showed that seeding by silica polymers formed during shutdowns has been the major factor in promoting scaling in the studies carried out thus far. In a run at pH 6 with 1 M NaCl, no deposits formed during 58 h of continuous operation without seeding, but substantial scale formed in 13 h of continued operation after a 17 h shutdown to allow seeding to take place. Such seeded scales show strong dependence of the amount and nature of the deposit on temperature of deposition. The rate of buildup is also substantially enhanced by raising the sodium chloride concentration from zero to one molar.

54186 (UCRL—79340) Overview of the geothermal energy development program at the Lawrence Livermore Laboratory. Austin, A.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Apr 1977. Contract W-7405-ENG-48. 45p. Dep. NTIS, PC A03/MF A01.

The program consists generally of development of advanced conversion systems, with strong emphasis on a systems approach to find solutions of the problems of scale formation, corrosion/erosion of materials, spent brine disposal and solids handling, and development of reliable, efficient energy conversion systems with strong emphasis on development of the total flow concept. The status of the various parts of this program is reviewed briefly. (MHR)

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

54187 (COO—4051-4, pp 14p., App. A) Geothermal energy conversion. Chapter III. Production well flow. Elliott, D.G. (Jet Propulsion Lab., Pasadena, CA). 1977.

From 4. meeting of the centers for the analysis of thermal/mechanical energy conversion concepts; Berkeley, California, United States of America (USA) (24 Jan 1977).

In Minutes: fourth meeting of the centers for the analysis of thermal/mechanical energy conversion concepts.

A draft of the chapter on Production Well Flow for the proposed Geothermal Energy Sourcebook is presented. The analysis begins with simple ideal cases and proceeds to a computer method which correlates observed well characteristics by fitting at the well bottom and (where heat loss is significant) at the wellhead. The findings indicate that, from a wellhead availability standpoint, self-flow is preferred over pumped wells for many reservoirs, particularly for temperatures over 150°C (300°F). (MHR)

54188 Study of reinjection at Otake geothermal field. Onodera, S.; Fukuda, M. *Kyushu Daigaku Kogaku Shuho;* **49**: No. 6, 829-835(Dec 1976). (In Japanese).

A simple model of a hot water thermal system was developed for determining the effects of reinjection on a geothermal field. The model involved parameters of enthalpy and flow rate for a production well yielding a mixture of steam and water. The output of the production well was found to vary with the flow rate and enthalpy of reinjected fluid. Various combinations of steam and water reinjection and productions were studied. Reinjection was carried out at the Otake geothermal field and the results were compared to those derived from the model.

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

54189 (LA-UR—77-828) Results of fluid-circulation experiments: LASL hot dry rock geothermal project. Smith, M.C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 6p. (CONF-770440—3). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, Colorado, United States of America (USA) (12 Apr 1977).

The first large-scale field experiment to investigate the extraction of heat from hot dry rock is now in progress on the Jemez Plateau in northern New Mexico. The experimental system consists of two holes about 3 km deep, from each of which hydraulic fractures have been made. The two major fractures appear to be approximately vertical and parallel, and separated by about 9 m of granodiorite through which fluid is transmitted probably along a distributed set of secondary fractures. Experiments to this point have demonstrated that the surface area of each hydraulic fracture is sufficient to accomplish effective heat transfer from the rock, at about 200°C, to water circulated through the system; that there is no significant short-circuiting of the water within the fractures; but that the impedance to fluid flow through the rock between the fractures is too high to permit the rate of heat extraction (initially about 10 MWt) desired of the experimental system. An attempt to reduce impedance by leaching with dilute sodium carbonate solution was unsuccessful. Therefore an attempt is now being made to reduce it by re-drilling from near the bottom of one hole in order to produce a simple system geometry in which the two holes are connected directly through a single hydraulic fracture.

54190 (LA-UR—77-1298) Energy extraction characteristics of hot dry rock geothermal systems. Tester, J.W.; Smith, M.C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 9p. (CONF-770804—6). Dep. NTIS, PC A02/MF A01.

From 12. intersociety energy conversion engineering conference; Washington, District of Columbia, United States of America (USA) (28 Aug 1977).

The LASL Hot Dry Rock Geothermal Energy Project is investigating methods to extract energy at useful temperatures and rates from naturally heated crustal rock in locations where the rock does not spontaneously yield natural steam or hot water at a rate sufficient to support commercial utilization. Several concepts are discussed for application to low and high permeability formations. The method being investigated first is intended for use in formations of low initial permeability. It involves producing a circulation system within the hot rock by hydraulic fracturing to create a large crack connecting two drilled holes, then operating the system as a closed pressurized-water heat-extration loop. With the best input assumptions that present knowledge provides, the fluid-flow and heat-exchange calculations indicate that unpumped (buoyant) circulation through a large hydraulic fracture can maintain a commercially useful rate of heat extraction throughout a usefully long system life. With a power cycle designed for the temperature of the fluid produced, total capital investment and generating costs are estimated to be at least competitive with those of fossil-fuel-fired and nuclear electric plants. This paper discusses the potential of the hot dry rock resource, various heat extraction concepts, prediction of reservoir performance, and economic factors, and summarizes recent progress in the LASL field program.

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 54178

54191 Application of geothermal energy in addition to power generation. Sekioka, M. (Defense Academy, Dept. of Geometry, Japan). *Doryoku;* **35**: No. 135, 251-257(1975). (In Japanese).

Although the primary thrust of geothermal research is towards electrical power generation, the hot water generated as a by-product can be used in many diverse applications. Most common among these are the heating and cooling of domestic dwellings, agricultural areas, fish ponds, therapeutic baths and roadways. Steam can be used to generate electricity by direct application in turbines, or, at lower temperatures, by vaporizing a secondary fluid such as freon or isobutane. After use in power generation equipment the remaining thermal energy can be extracted and used for domestic water heating. It is advisable to utilize the greatest possible amount of heat energy prior to discharge of the fluid into the environment. Secondary heat extraction of this type is performed at the Hatchobara and Otake geothermal fields as well as at Matsukawa. At the Onuma geothermal field 260 t/h of weakly alkaline hot water is used for therapeutic bathing purposes. Tables giving the power output in kW of geothermal fields in the US, Japan, Italy, New Zealand, Mexico, El Salvador, the Philippines, Iceland and the USSR are provided.

54192 Method of making paper using geothermal energy. Hayashi, T. Japanese Patent Sho 51-123303. 28 Oct 1976. Filed date 21 Apr 1975. 2p. (In Japanese).

A patent disclosure and application was filed for a method of making paper using geothermal energy. The method involves the utilization of high pressure steam from a geothermal well in a drying device. The device or method would greatly decrease the production cost of paper and would eliminate the air pollution associated with the burning of fossil fuels in conventional paper mills. The excess steam from the process could be used for the generation of electricity for use in other areas of the paper mill.

54193 (ERDA-tr—260) Geothermal energy: residential space heating. Mar 1977. Translation of La Geothermie: chauffage de logements. (NATO/CCMS—59). 26p. Dep. NTIS, PC A03/MF A01.

The purpose of this study was to determine the best way to use geothermal hot water for residential space heating. It became apparent that the type of heating apparatus used in the housing units was most important and that heat pumps could be a valuable asset, making it possible to extract even more geothermal heat and thus substantially improve the cost benefit of the systems. After a first stage devoted to analyzing the problem through a manual method which proved quite useful, the systematic consideration of all important aspects led us to use a computer to optimize solutions and process a large number of cases. The software used for this general study can also be used to work out particular cases. This program makes it possible to take climatic conditions into account in a very detailed manner, including temperatures as well as insolation. 864 cases corresponding to 36 typical days divided into 24 hours each were chosen to represent the heating season. They make it possible to define the heating needs of any type of housing unit. The code simulates and analyzes the behavior in practice of a geothermal heating system when heat is extracted from the well by a simple heat exchanger.

54194 Iceland harnesses heat from lava while geothermal projects gather steam. *Eng. News-Rec.;* **198**: No. 21, 25(26 May 1977).

A pilot installation in the Vestman Islands (Iceland) has successfully delivered 85-90°C water to a hospital and 40 residences. Plans call for expansion of the facility to heat most of the 1000 residences in the town of Vestmannsaeyjar. The system utilizes steam produced by 1000°C lava beneath 10-20 m of volcanic ash produced by a volcanic eruption in 1973. Pipes in 1.6 m diameter holes carry steam to heat exchangers. The lava fields are expected to produce steam for about 15-20 years and research is underway on methods of prolonging their usefulness. Also in Iceland, the city of Reykjavik has been using geothermal heat since 1930. Approximately 46% of the homes were heated geothermally in 1973 and the present goal is to provide heat to 77% by 1985. A 1% sales tax has produced 4 million dollars for geothermal R D. Eleven wells at Laugavegur produce 18,000 liters/min of water at 128°C and five wells at Ellioaar produce about 10,000 liters/min at 103°C.

GEOTHERMAL DATA AND THEORY

54195 Theory of magma formation. Kushiro, I. *Kagaku (Tokyo);* **45**: No. 1, 2-8(Jan 1975). (In Japanese).

Models which explain the origin of various magmas are presented, based on the physicochemical properties of silicate melts. In the system MgO-SiO_2-K_2O the liquid phase equilibria for two types of melt having different degrees of SiO_4 polymerization shift toward SiO_2 when oxides of monovalent elements are dissolved in the melt. When multivalent elements are dissolved, the equilibria shift away from SiO_2. This was shown to hold true in experiments using CO_2 and P_2O_5. The effect of pressure on the system MgO-SiO_2-X (where X = K_2O, CaO or TiO_2) was examined. In general, the boundary of Mg_2SiO_4 and $MgSiO_3$ moves away from silicate composition with increased pressure but the effect is not obvious with TiO_2. It is believed that alkaline magmas containing H_2O or CO_2 may be formed through partial melting or zone melting in the mantle. High pressures are not required in the presence of abundant

CO_2, P_2O_5 or TiO_2. Alkaline basalt and Soleaito' magmas are believed to derive from the fractionation of a partial melt.

54196 High pressure phase equilibria and the constitution of the Earth's mantle. Ito, E. (Okayama Univ., Inst. of Thermal Spring Res.). *Atsuryoku Gijutsu;* 14: No. 5, 22-31(1976). (In Japanese).

Recent achievements in phase equilibria experiments concerning the structure of the deep mantle are reviewed. Three types of ultra-high pressure equipment for conducting studies in the range of pressure exceeding 200 bars have recently been developed. A two stage divided globe developed by the Kawai research group of Osaka University is capable of 300 bars at high hydrostatic pressures. A sliding multi-anvil device (MASS318) developed by the Kumazawa group at Nagoya University has essentially unlimitd pressure capability. At Rochester University in the US a diamond anvil cell capable of 300 bars pressure and temperatures of 3000°C has been produced. As a result of experiments with these devices the structure of the mantle is becoming better understood. The determination of precise phase equilibria of silicates can yield not only the phase transformations and mineral assemblages but also information which can be applied to temperature estimation. The diamond anvil cell has been especially useful in this respect, although precise measurements of temperature and pressure above 150 bars is not yet possible. Forty references are given and phase diagrams for magnesioaluminosilicates are provided.

54197 Thermal conductivity and temperature in the upper mantle. III. Slawomir, M. (Inst. of Geophys., Univ. of Warsaw). *Acta Geophys. Pol.;* 24: No. 1, 25-49(1976). (In Polish).

A numerical model of the Earth's upper mantle was developed. This model, together with measurements of generative radioactive heat consistent with that of chondritic meteorites, require the consideration of three types of energy transport. These are phonon conductivity, radiative conductivity and exciton conductivity. For other models the phonon conductivity and mass flux (convection) can be assumed. A radial mass velocity of 0.1 mm/yr is sufficient for this purpose. For eclogite models, phonon and radiative conductivity serve to explain energy transfer at depth. Two new semi-empirical relationships have been derived. These are between phonon conductivity and the silicate seismic parameter, and between phonon conductivity and density/atomic weight for silicates and oxides. It appears that phonon conductivity in the upper mantle remains constant. The relationships between the refractive index of thermal radiation and upper mantle density can be derived from the dispersion formula of the Lorentz electron theory if the models obey Birch's law and a law where (U) = approximately 11/9 eV.

54198 Conceptual pattern concerning the study of geothermalism and the thermalization process of underground waters in Romania. Airinei, S.; Pricajan, A.; Bandrabur, T. *Rev. Roum. Geol., Geophys. Geogr., Ser. Geol.;* 20: No. 2, 283-298(1976). (In Romanian).

The problems of the mechanisms of geothermal manifestations in Romania, particularly as they relate to exploration, are a primary focus of geophysical research in that country. Thermal processes and their deep origins are still in a highly speculative theoretical state. These thermal phenomena must be studied in terms of the integration of diverse information concerning terrestrial physical functions. To accomplish this it is necessary to combine data on physical geology; magnetic and gravitational anomalies; seismic and electrometric functions; thermal and radioactive phenomena; and hydrology. The production of carbon dioxide in Romanian wells, in some cases 99% pure, also poses a puzzling relationship which may be related to plate-tectonic theory and may result from still active subduction processes in the Carpathians.

PROPERTIES OF AQUEOUS SOLUTIONS

REFER ALSO TO CITATION(S) 54161

PROPERTIES OF MINERALS AND ROCKS

54199 (UCRL—79013(Pt.1)) **Time-dependent electrical parameters of rock-solution systems. Part I.** Weed, H.C.; Piwinskii, A.J.; Keller, P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Apr 1977. Contract W-7405-ENG-48. 27p. (CONF-770609—1). Dep. NTIS, PC A03/MF A01.

From SPE international symposium on oilfield and geothermal chemistry; San Diego, California, United States of America (USA) (27 Jun 1977).

The electrical conductivity of 25.4 mm diameter cylindrical cores of sedimentary and igneous rocks was measured at a frequency of 1 kHz under ambient conditions after saturation in tap water and in 0.1 M NaCl solution. Between measurements, each rock was stored in contact with its own separate solution which at the start of the experiment was either tap water or 0.1 M NaCl solution. Eighteen rocks having porosities between 0.07 and 42 percent were investigated; ten were sedimentary, eight were igneous. All solution conductivities were measured employing a dip cell. The time dependence of the conductivity was investigated as well as the range of validity of Archie's Law. The Formation Factor and conductivity of rock specimens and their reacting solutions display time-dependent behavior up to 8000 hours. The Formation Factor and electrical conductivity depend on the salinity of the pore fluid, the rock porosity and permeability, and the clay minerals present in the rock.

54200 Alteration minerals in Kamoh-cho, Kagoshima prefecture. Tomita, K. (Inst. of Earth Sci., Fac. of Sci., Kagoshima Univ.); Ita, H. *Kagoshima Daigaku Rigakubu Kiyo;* No. 8, 1-13(1975). (In Japanese).

Four types of andesites are found in the Akanita area of Kamoh-Cho. They are hydrothermally altered and can be divided into three distinct zones by characteristic mineral associations. Zone I is composed primarily of alunite and contains kaolinite, sericite, chlorite and pyrite. Zone II has a mixed-layer mineral of mica and montmorillonite and contains mordenite, epidote and pyrite. Zone III is abundant in montmorillonite and contains mordenite, alpha-cristobalite, quartz and plagioclase. A mixed-layer mineral of mica/montmorillonite has 27.6 angstroms of (001) reflection and was probably formed by degradation of sericite.

ROCK-WATER-GAS INTERACTIONS

REFER ALSO TO CITATION(S) 54184, 54199

TIDAL POWER

54201 Energy from the oceans. *S. Afr. J. Anim. Sci.;* 4-5(Jun 1976).

From 3. International Marine Research, Engineering and Economics Congress and Exhibition; Duesseldorf, Germany, F.R. (15 - 19 Jun 1976).

Since the world reserves of conventional primary sources, such as coal, oil and gas, are not unlimited and may be exhausted before the century is out, alternative means of power generation have been sought. The exploitation of the mechanical energy of the sea has received almost universal approval. The tidal power station is employed for exploiting the potential energy of the sea, which takes three basic forms: dynamic energy, through the motion of waves, tides and currents, heat energy in the various layers between the sea surface and deep water, and the substances contained in the seawater itself.

WAVE ENERGY CONVERTERS

54202 (COO—2946-1) **Wave and salinity gradient energy conversion.** (Delaware Univ., Newark (USA)). 1976. Contract EY-76-C-02-2946. 467p. (CONF-760564—). Dep. NTIS, PC A20/MF A01.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976).

Separate abstracts were prepared for each of the thirteen papers included. (JWR)

54203 (COO—2946-1, pp D.1-D.20) **Environmental effects arising from salinity gradient and ocean wave power generating plants.** Zeigler, J.M.; Hyer, P.V.; Wass, M.L. (Virginia Inst. of Marine Science, Gloucester Point). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976).

In Wave and salinity gradient energy conversion.

The environmental effects of salinity gradient and wave power generating plants are discussed in the following areas: temperature impacts, salinity impacts, additives, fresh water needs, direct impacts, site specific impacts, and air quality and aesthetics. (MHR)

54204 (COO—2946-1, pp E.1-E.29) **Temporal and spatial variability of power from ocean waves along the west coast of North America.** Pierson, W.J. Jr.; Salfi, R.E. (CUNY Inst. of Marine and Atmospheric Sciences, New York, NY). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976).

In Wave and salinity gradient energy conversion.

The applicability of computer based numerical wave hindcasts to the calculation of the day to day variations of available wave power off the west coast of North America is illustrated. The limited data base will be greatly improved in a few more years if present plans mature. The techniques can eventually be extended to the world ocean. The results show that available wave power is highly variable on a day to day basis and from winter to summer for the grid points that were studied. Other locations would be much less variable. Various trade off and design considerations have been mentioned that may serve as a guide in pursuing these matters further.

54205 (COO—2946-1, pp F.1-F.36) **Utilization of the energy from ocean waves.** Isaacs, J.D.; Wick, G.L.; Schmitt, W.R. (Univ. of California, San Diego, La Jolla). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976). In Wave and salinity gradient energy conversion.

An assessment of the extent and distribution of wind-wave energy in the oceans is presented. This is followed by a review of some conventional and unconventional mechanisms for the harnessing of the power of waves. The design and performance of a wave-powered pump developed at Scripps is described.

54206 (COO—2946-1, pp G.1-G.23) **Effect of nonlinearities on wave power estimates.** Hudspeth, R.T. (Slotta Engineering Associates, Inc., Corvallis, OR). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976). In Wave and salinity gradient energy conversion.

It is shown that the Dean Stream Function Tables may be used to estimate relative errors in the values of average total energy flux computed by the numerical nonlinear Dean Stream Function and by classical linear wave theory. A contour of zero relative error between nonlinear theory and linear wave theories was found on the relative wave steepness—relative water depth dissection plane used by Dean to define his 40 tabulated Stream Function cases. Lower limits for relative water depths for which the effects of nonlinearities on deterministic estimates of recoverable wave power may be neglected for engineering purposes are summarized. An extremal of the positive relative error (underestimation by deterministic linear wave theory) occurs in deep water for waves which demonstrate a relative wave steepness of approximately 75 percent of the breaking limit.

54207 (COO—2946-1, pp H.1-H.186) **Recoverable wave power concepts.** Slotta, L.S. (Slotta Engineering Associates, Inc., Corvallis, OR). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976). In Wave and salinity gradient energy conversion.

A presentation is made of a number of available wave energy conversion devices, oceanic water wave power locations of associated high power density areas, and some concepts for amplifying ocean waves for increased power.

54208 (COO—2946-1, pp I.1-I.55) **Preliminary feasibility study for utilization of water wave energy.** Nath, J.H.; Williams, R.M. (Oregon State Univ., Corvallis). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976). In Wave and salinity gradient energy conversion.

The purpose of this study was to make a preliminary assessment of the latent wave energy in areas of the United States coastlines where wave energy plants may be located, and to examine the economics of construction and operation. This report presents the results of: an estimate for the total yearly energy content in ocean waves; an estimate for the annual cost of energy conversion, including construction and operating costs; an estimate of the cost-benefit ratio based on the sale price for electrical energy; and a very preliminary assessment of environmental impact from wave energy conversion devices.

54209 (COO—2946-1, pp J.1-J.48) **Power resource potential of ocean surface waves.** Panicker, N.N. (Woods Hole Oceanographic Institution, MA). 1976.

From The wave and salinity gradient energy conversion workshop proceedings; Newark, Delaware, USA (24 May 1976). In Wave and salinity gradient energy conversion.

A review of the technology of useful conversion of wave power and an estimation of the total wave power available and its distribution are presented. Wave power conversion devices include propulsion schemes, buoy power supply devices, offshore power plants and shore-based power stations. The distribution of wave energy and power as functions of longitude and latitude are presented for the Northern Hemisphere at 12Z, October 2, 1975. Both the large peak of the distribution in the Atlantic Ocean and the smaller peak in the Pacific Ocean are found to be at longitudes towards the eastern end of the ocean basins. This "eastern accumulation" of wave energy and power offers interesting contrast to the western intensification of currents. Distribution of wave power with latitude shows peaks of wave power in the mid-latitudes. The total surface wave energy in the seas of the world for the same time is estimated to be 1586.3×10^{15} joules. The corresponding total wave power estimate is 89.3×10^{15} watts. The rate of renewal of wave power is estimated to be 10^{12} to 10^{13} watts, about the present level of world power consumption.

54210 **Tapping ocean wave energy for powering gas turbine plants.** LaStella, J. *Gas Turbine World;* 5: 38-40(May 1975).

A new device invented by M. Tornabene of the Amanda Machinery Co. converts random wave action into mechanical or electrical power. In combination with gas turbine/generators, it makes for an extremely efficient peaking plant and, with provision for energy storage during off-hours (possibly through water electrolysis for hydrogen production), for a baseload power plant. The device offers low cost, long service life, and low maintenance needs.

54211 **Power resource estimate of ocean surface waves.** Panicker, N.N. (Woods Hole Oceanographic Institution, MA). *Ocean Eng.;* 3: No. 6, 429-439(Dec 1976).

The distribution of wave energy and power as functions of longitude and latitude are presented for the Northern Hemisphere at 12Z, October 2, 1975. Both the large peak of the distribution in the Atlantic Ocean and the smaller peak in the Pacific Ocean are found to be at longitudes towards the eastern end of the ocean basins. This "eastern accumulation" of wave energy and power offers interesting contrast to the western intensification of currents. Distribution of wave power with latitude shows peaks of wave power in the mid-latitudes. The total surface wave energy in the seas of the world for the same time is estimated to be 1600×10^{15} J. The corresponding total wave power estimate is 90×10^{15} W. The rate of renewal of wave power is estimated to be 10^{12}—10^{13} W, about the present level of world power consumption.

WIND ENERGY

AVAILABILITY (CLIMATOLOGY)

REFER ALSO TO CITATION(S) 53606

54212 (SAND—77-0696C) **New details on wind power climatology.** Reed, J.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. 26p. (CONF-770539—1). Dep. NTIS, PC A03/MF A01.

From American Wind Energy Association meeting; Boulder, Colorado, United States of America (USA) (13 May 1977).

The national isodyn map of average available wind power was used to help select fifteen stations, representative of interesting wind power climatic regimes, for detailed analyses of ten-year records of hourly wind speed observations. These long time series have been corrected for observer bias, homogenized to constant anemometer exposures, and extrapolated to select heights 10m, 20m, and 50m above flat terrain. Various analyses have shown that correction generally gave results in excellent agreement with the national isodyn contours, turbine cut-in and cut-off speed selections were not critical to power recovery efficiency, turbine rated speed needs to be tailored to the regional wind climate, stand-alone systems require huge storage filters to smooth annual and inter-annual variations in supply, and modest storage will effectively filter periodicities of a few days in both supply and demand.

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

54213 **Optimum wind-energy conversion systems.** Huetter, U. (Univ., Stuttgart). pp 399-419 of In Annual review of fluid mechanics. Vol. 9. Van Dyke, M. (ed.). Palo Alto, CA; Annual Reviews, Inc. (1977).

Information on optimum characteristics of wind turbines is presented concerning the advantages of high specific speed, limitations for specific speed, rotor characteristics at stall state, the rotor's disc-velocity coefficient, vortex-state problems, the near-critical operating rotor (NCR), refinements simplifications, and optimum rated power.

54214 (N—77—17562) **The optimum configuration of rotor blades for horizontal wind energy converters.** Weber, W. Translation of *Z. Flugwiss.;* 23: No. 12, 443-447(Feb 1977). 17p. (NASA-TT-F—17379). NTIS, PC A02/MF A01.

Considerations, procedures and some results relating to the problem of the aerodynamic configuration of rotor blades for wind energy converters are presented.

SITE CHARACTERISTICS

REFER ALSO TO CITATION(S) 54212

ELECTRIC POWER ENGINEERING

REFER ALSO TO CITATION(S) 54700

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 53605, 53716, 53747

54215 Method and apparatus for lifting the steam temperature in the superheater of power plants. Hochmuth, F.W. (to Combustion Engineering, Inc., Windsor, Conn. (USA)). German(FRG) Patent 2,551,430/A/. 1 Jul 1976. 15p. (In German).

While the steam generator for the main burden of operation of a power plant is fitted for continuous operation, those put into operation for fluctuating loads must be equipped for intermittent service. Above all they must be moderated to the high requirements of the steam generator and turbine running temperature differences. The method to date of increasing the steam temperature at the superheater decreases the efficiency of the power plant. The invention deals with a method, which makes it possible to increase the steam temperature without reducing the efficiency of the power plant. For this purpose a bypass circuit is provided which withdraws a controlled amount of fluid before the steam generator, for the purpose of withdrawing a controlled amount of heat and this cooled and withdrawn amount of fluid is lead to the separator, whereby the amount of steam which is lead to the superheater is reduced. The withdrawn amount of heat is lead into another fluid circuit at low pressure, whose steam finds its way to a lower pressure stage of the turbine.

54216 Some results of the testing of an automatic control loop for the constant-pressure 300 MW unit of Kirisch power plant. Ivanov, V.A.; Michailov, S.Ya.; Stepa, V.G.; Myskin, N.S.; Fomin, V.A.; Kulikova, G.G.; Popov, V.E. (Leningradskij Politekhnicheskij Inst. (USSR)). *Arch. Energiewirtsch.;* **30**: No. 11, 1006-1012(Nov 1976). (In German).

4 figs.; 8 refs. Translated from Russian: Nekotorye rezul'taty ispytanija sistemy avtomaticeskogo regulirovanija bloka 300 MWt kirischskoj GRES pri skol'zj szem davlenii. Also published in Izvestija Vuzov, energetika-Hochschulmitteilungen, Energetik, (Apr 1976) v. 19(4) p. 75-81.

The thermal efficiency at very low loads of the 300 MW units of Kirisch power station is to be improved by a suitable control programme. At present, this is done either by boiler output control or by pressure control. A combination of the two types of control is now being developed and tested. The tests proved the good operation of the proposed control technique; rated power and live steam pressure were kept constant, the turbine control valves were correctly adjusted and only boiler control requires further stabilization. - The report was originally printed in 'Izvestija VUZov, energetika', 19 (1976), No. 4, p. 75-81.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

REFER ALSO TO CITATION(S) 54492

54217 (BNWL—2123) Costs and cost algorithms for dry cooling tower systems. Ard, P.A.; Henager, C.H.; Pratt, D.R.; Wiles, L.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1976. Contract EY-76-C-06-1830. 186p. Dep. NTIS, PC A09/MF A01.

Costs were obtained and cast models prepared for the major components beyond the turbine exhaust flange of a dry cooling system using either water or ammonia as the intermediate heat exchange fluid. (LCL)

54218 (K/CSD/INF—77/1) Computerized engineering model for evaporative water cooling towers. Park, J.E.; Vance, J.M.; Cross, K.E.; Van Wie, N.H. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Computer Sciences Div.). 1977. Contract W-7405-ENG-26. 21p. (CONF-770516—1). Dep. NTIS, PC A02/MF A01.

From Conference on waste heat management and utilization; Miami Beach, Florida, United States of America (USA) (9 May 1977).

The evaporative cooling tower is often used to reject waste heat from industrial processes, especially power plants and chemical facilities. A consistent physical model for crossflow and counterflow cooling towers which imposes rigorous heat and mass balances on each increment of the tower under study is presented. Individual towers are characterized by specification of a mass evaporation rate equation. The solution algorithm allows reduction of test data, interpolation of the reduced data, and comparison of test results to design data. These capabilities can be used to evaluate acceptance tests for new towers, to monitor changes in tower performance as an aid in planning maintenance, and to predict tower performance under changed operating conditions.

54219 (ORNL/TM—5357) Review of cooling tower drift deposition models. Chen, N.C.J. (Oak Ridge National Lab., Tenn. (USA)). 4 May 1977. Contract W-7405-ENG-26. 99p. Dep. NTIS, PC A06/MF A01.

The behavior, basic assumptions, and limitations of ten different models for calculating the drift deposition rate from wet cooling towers are reviewed and then their predicted results for such deposition with a common set of input parameters are compared. The predicted maximum deposition differs among the models by two orders of magnitude with a wide range in peak location. Comments and suggestions to improve the models are included.

54220 Integrated approach to assess and resolve the environmental problems associated with power plant cooling systems. Chezar, B. pp 518-524 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

An integrated program is being conducted to seek methods for reducing the impact of power-plant cooling systems on the aquatic environment and to help analyze the need for alternative cooling methods (e.g. cooling towers). The program integrates three elements: (1)Remote sensing of water quality parameters and terrestrial vegetative effects, using advanced aerial survey techniques; (2) Formulation of a quantitative approach to assessing thermal impact in a biologically meaningful way; (3) Development of experimental devices to evaluate in-plant effects on entrained organisms, and to reduce the percentage of organisms impinged and entrained. The approaches being followed and results to date are described.

54221 Structure of natural draft cooling towers, 1. Study on cooling tower shells. Ishioka, H.; Sakamoto, Y.; Tsurusaki, M.; Koshizawa, K.; Chiba, T. (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan)). *Ishikawajima-Harima Giho;* **16**: No. 5, 559-566(Sep 1976). (In Japanese).

Recently in Japan, demands for cooling tower systems have been increasing remarkably with the construction of large power plants and the legislation of environmental regulations. In view of the severe natural conditions in Japan such as strong wind and seismic loadings, etc., the establishment of the optimum design and construction method is essential for the building of safe and economical towers. In order to establish a comprehensive plan of a power plant cooling system of the appropriate structural type, the authors have made researches and experiments on design conditions, static and dynamic analyses, and comparative studies of various structural types such as reinforced concrete thin-shell structures, steel framed structures and composite shell segment structures, based on the investigation results of towers in Europe and America. These results are presented in three reports, the 1st of which concerns cooling tower shells as are herein described.

54222 Thermal performance models and drift loss predictions for a spray cooling system. Chen, K.H.; Trezek, G.J. (Department of Mechanical Engineering, University of California, Berkeley, Calif.). *J. Heat Transfer;* **99**: No. 2, 274-280(May 1977).

The relation between the Spray Energy Release (SER) and the spray nozzle efficiency (eta) is considered with the view toward increasing the utility of previous spray thermal performance information. Through the approximate analysis of an assumed counterflow process, the relevant parameters that eta depends upon have been identified as the total heat transfer factor c'/c/sub w/, the sensible heat factor phi, and the SER. In general eta cannot be correlated with wind speed alone. Similarities and differences between the NTU and SER methods are also considered. Values of SER are established from data obtained from a prototype spray system and a laboratory scale single column spray system. A simplified drift loss prediction model which is in good agreement with experimental data is proposed for an open atmosphere spray system.

POWER CYCLES

54223 (FE—2292-7) Development of high temperature subsystem technology to a technology readiness state: phase I. Second quarterly technical progress report, September—November 1976. Carlson, N.G. (United Technologies Corp., Farmington, Conn. (USA). Power Systems Div.). Dec 1976. Contract EX-76-C-01-2292. 199p. Dep. NTIS, PC A09/MF A01.

The High-Temperature Turbine Technology Program (HTTTP) is directed towards developing the required technology to use coal-derived fuels in an efficient and environmentally acceptable manner to produce electric power. Phase I program and system definition, is proceeding and is a nine-month effort. Because of the operational requirements of this system, special emphasis is placed on developing turbine subsystem technology to a state of readiness. Durability is a key consideration due to the nature of the operating environment and rigorous duty cycle. In addition, the program addresses investigation of unique turbine cooling schemes as well as the application of advanced materials since operating temperature levels of growth generations will approach near stoichiometric proportions. The technology developed and demonstrated during this

program is expected to have wide application. Commercial utilities using this technology could be producing electricity from coal-derived fuels by the mid-1980 time period. Work is reported under the following tasks: (1) preparation of overall plant design description; (2) baseline combined-cycle systems for gas and liquid fuels; (3) turbine subsystem design; (4) identification of research and technology requirements; (5) Phase II program; (7) preliminary design of low-Btu gas combustors; and (8) technology development for low-Btu gas combustors.

54224 (FE—2371-T-1) **Evaluation of a pressurized-fluidized bed combustion (PFBC) combined cycle power plant conceptual design. Quarterly report, October 1—December 31, 1976.** Huber, D.A. (Burns and Roe Industrial Services Corp., Paramus, N.J. (USA)). 20 Jan 1977. Contract EX-76-C-01-2371. 40p. Dep. NTIS, PC A03/MF A01.

Progress is reported in preparing a conceptual design for an electric power plant that will directly combust high-sulfur coal in a pressurized, fluidized-bed combustor in conjunction with combined gas/steam turbine cycle to generate electric power in an environmentally acceptable manner. Performance calculations continued on various cycle configurations, e.g., basic combined cycle (no reheat or exhaust firing); exhaust fired combined cycle; reheat at power turbine inlet; and reheat at low turbine inlet plus exhaust firing. Preliminary designs have been completed for a PFB (pressurized fluidized-bed) combustor operating at 10 atmospheres; a PFB combustor operating at 2-1/2 atmospheres; and a steam-cooled atmospheric fluidized-bed cumbustor. Efforts continued on trade-off studies to optimize performance and economics; preparation of general equipment arrangements; determination of the coal and stone unloading and handling systems; and determination of the ash and spent stone handling system.

54225 Studies of the basic properties of a power unit with peak-load gas turbine. Kirillov, I.I.; Arseniev, L.V.; Korsov, Yu.G.; Poliszuk, V.L.; Chodak, E.A. (Leningradskij Politekhnicheskij Inst. (USSR)). *Arch. Energiewirtsch.;* **31**: No. 1, 43-47(Jan 1977). (In German).

4 figs.; 1 tab.; 4 refs. Translated from Russian: Analiz osnovnych svojstv parosilovogo bloka s pikovoj GTU. Also published in Teploenergetika (1976) v. 23(5) p. 29-31.

Electrical loads in modern combined-cycle operation differ so much that considerable peak and mixed loads are required to meet the demand. To achieve these peak loads in a power station, the feed heaters may be preheated by the off-gases from a connected gas turbine which also generates additional power. A combined gas-steam power plant of this type was studied which consists of a modern condensing steam turbine and a peak-load gas turbine. It was found that the efficiency may be increased by 50 to 60% by shutting down all feed heaters and connecting a gas turbine. - The article was originally printed in 'Teploenergetika', 23 (1976), No. 5, p. 29.

COMPONENTS

REFER ALSO TO CITATION(S) 53699, 54705

54226 (AD-A—038878) **Experimental and analytical study of a steam vane expander.** Robertson, G.F. (Pennsylvania State Univ., University Park (USA). Applied Research Lab.). 1 Feb 1977. Contract N00017-73-C-1418. 139p. (TM—77-65). NTIS PCA07/MF A01.

Thesis.

An experimental and analytical study of a rotary vane steam expander was conducted to determine the effect of leakage, friction and heat transfer on the expander performance. A commercially available rotary vane air motor was modified to operate on steam utilizing little or no liquid lubricant. The indicated power output, shaft power output and frictional power loss of the vane expander were experimentally determined as a function of speed, inlet timing and supply steam conditions. The steam mass flow rate and component temperatures were also measured. The data show that severe internal leakage and frictional energy dissipation were major causes of efficiency reductions. An analytical model of the expander thermodynamics, friction, leakage and heat transfer was developed from fundamental principles. The model predicts the expander leakage flow rate, frictional power loss heat transfer rate and the effect of these losses on the power output and efficiency. The analytically and experimentally determined frictional power losses were in agreement. The component temperature profiles were predicted with maximum errors of 10% to 15%. The predicted leakage flow was approximately 16% below the experimentally determined value. Errors in the leakage flow predictions resulted in the predicted indicated power outputs being 20% to 40% below the experimental values. This was considered reasonably good in light of the difficulty in identifying the steam leakage paths and component clearances.

54227 Gas turbine jet engine. Cross, W.G. (to Secretary of State for Defence, London (UK)). German(FRG) Patent 1,751,651/B/. 20 May 1976. 9p. (In German).

The invention concerns a gas turbine jet engine with an after burner in the jet tube and an adjustable cross-section discharge nozzle. The nozzle adjustment drive is set by a first control arrangement working from the jet pressure which can be overruled under certain conditions by a second control arrangement. The fuel supply of the after-burner is operated manually. According to the invention the control arrangements for the nozzle adjustment drive are designed so that the cross-sectional surface of the discharge nozzle has the optimum value under all possible operating conditions of the after-burner, e.g. during ignition, at high acceleration or when switching off.

54228 Gas turbine system with a guide wall of several plates to limit the hot gas flow. Matto, L.B. (to Avco Corp., Cincinnati, Ohio (USA)). German(FRG) Patent 2,356,722/B/. 30 Sep 1976. 5p. (In German).

The invention concerns a gas turbine system with a guide wall of several plates, which deflects the hot gas flow produced by the combustion chamber by 180°. This guide wall is formed by three bent plates, where the middle plate is kept, independent of the thermal load, at the same distance from the two other plates by suitable convex parts on both sides, so that two cooling air chambers are formed. Cooling air from the compressor air pipe is taken to these cooling air chambers. Two inlets are provided at the end of the guiding wall upstream for this purpose. Outlets are also provided at the downstream end which take the cooling air to the hot gas flow.

54229 Dynamic parameters of a reheater for the steam generator of the 800 MW unit in the Slawjansk power station in the case of anthracite dust firing. Berezinec, P.A.; Berezinec, A.A.; Kirillov, G.F.; Buckstein, I.I.; Rozengaus, I.N.; Gozozura, B.N. *Arch. Energiewirtsch.;* **30**: No. 10, 902-908(Oct 1976). (In German).

With anthracite dust firing, the fluctuating operation of the p.f. feeders leads to considerable disturbances in steam generation and to reheat temperatures which constantly exceed the permissible values. Reheater temperature control should therefore be made automatic. With this target in mind, the dynamic properties of the reheater were studied by inducing disturbances with the aid of control gate valves, changes in the air flow rate, boiler load etc. The reheater turned out to be rather insensitive to all types of disturbances, thus proving its good dynamic properties with regard to automatic control. The values obtained behind the first stage of the reheater should, however, not be used as control signals.

54230 Natural circulation water—pipe—steam generator. Svensson, G. German(FRG) Patent 1,751,039/C/. 25 Nov 1976. 5p. (In German).

The invention refers to a water tube boiler with combustion at the front wall. The combustion space is provided with pipes along its whole length. The given construction ensures that the shielded pipe wall and the steam surfaces lying behind it form a compact unit with the return pipes of the boiler, which can be transported as a unit. The great heat of the pipe wall normally produces a high suction effect at the pipes, which can lead to faults in the boiler water supply. According to the invention this is prevented by suitable measures.

WASTE HEAT UTILIZATION

54231 Some considerations on the utilization of thermal effluent for greenhouse heating by means of direct heat exchange system. Yamamoto, Y.; Aoki, K.; Minohara, Y. (Central Research Inst. of Electric Power Industry, Tokyo (Japan)). *Denshi Gijutsu Sogo Kenkyusho Chosa Hokoku;* No. 475001, 1-16(Sep 1975). (In Japanese).

The cost of maintaining the desired temperatures in winter is a principal element in the product of vegetables in greenhouse culture. Consequently, much lower heat costs and more profitable operations are possible if the warm water from the condenser (thermal effluent) of a power plant can be made available to the heat source for greenhouse heating. However, it is well known that the thermal density of thermal effluent is considerably low. For this reason the direct heat exchange system is commonly employed as the heat exchange between air in a greenhouse and the thermal effluent. In the case of the direct heat exchange system, not only sensible heat exchange but also latent heat exchange between the air and the water occurs. Therefore, the relative humidity of the air in the greenhouse reaches 100%. In this study, the authors carried out an experiment was carried out to demonstrate that tomato plants can be grown in a 100% humidity greenhouse environment and the yields are as good as that from a conventional greenhouse.

54232 Method for the transport and use of waste heat from power stations. Alefeld, G. *Brennst.-Waerme-Kraft;* **29**: No. 3, 94-98(Mar 1977). (In German).

It is proposed to use the waste heat for producing a high-pressure gas (e.g. ammonia, propane, difluorine-methane) which

flows by its own power to the consumer (ground heating, district heating station). After suppling with heat of condensation, the transport medium returns as a liquid to the power station. As the power for the transport is taken from the large working capacity of the high-pressure gas (corresponding to the difference between the condenser temperature and the ground temperature, for instance) the cross-sections of the pipe lines required are relatively small. This system makes it possible to lower the condenser temperature to 30 to 25°C, resulting in an improved efficiency of the power station of 36 to 39%, compared to the cooling tower operation at 33%. For district heating operation, the high-pressure gas is used as convenient heat source for heat pumps which is rich even on cold days. The advantages of the low-temperature, high-pressure steam transport are discussed, in comparison to hot water transport applied to ground heating and district heating. In respect of heat transport, ammonia has the best properties of the three materials investigated.

ECONOMICS

REFER ALSO TO CITATION(S) 54702

54233 Some theoretical and practical problems associated with the principles governing the policy of minerals utilization. Toth, M.; Simon, K.; Faller, G. pp I.5.1-I.5.10 of In Exploitation and beneficiation of mineral raw materials by the mining industry: a key to progress. Essen; Verlag Glueckauf GmbH (1976).

From 9. world mining congress; Dusseldorf, German, Federal Republic of (F.R. Germany) (May 1976).

See CONF-7605143—.

A general discussion is presented on costs of raw materials, including fossil fuels, and the costs of generating electricity using various fuel sources. (EJH)

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 54723

FUELS

REFER ALSO TO CITATION(S) 53818, 53906, 54704

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 53699, 54220, 54656, 55107

54234 (IIHR—184) Thermal-hydraulic model study of offshore discharge system for Kahe Power Plant, Hawaii. Jain, S.C.; Leonard, M.; Kennedy, J. (Iowa Inst. of Hydraulic Research, Iowa City (USA)). Jan 1976. 34p. of Iowa, Iowa City, IA.

The present investigation was concerned with the design of the outfall structure for the condenser cooling-water discharge from Kahe Power Plant. The recommended discharge structure consists of two 12-ft diameter pipes, each terminating into an 11-ft diameter nozzle discharging offshore at an angle of 20° above horizontal. The nozzles will be located at a water depth of 27 ft below MLLW. The model tests indicate that the recommended outfall configuration will satisfy both average and instantaneous criteria on temperature rise for longshore currents and for small Kona currents. Only under some larger Kano currents does the maximum instantaneous temperature at the bottom exceed 3°F and the maximum average temperature near the shoreline close to the baffles (installed to produce Kona currents) exceed 1.5°F and then only by small amounts.

54235 (NP—22244(Vol.3)) Environmental impact analysis of Coyote Station. Volume 3. (Stearns-Roger Corp., Denver, Colo. (USA)). Aug 1976. vp. Inc., Denver, CO.

Six appendices to the environmental impact analysis for the proposed 440 MW coal-fueled Coyote power plant near Beulah, N.D. are presented. These appendices contain information on observations, summaries, and analyses of onsite meteorological and air quality measurements for the period from Dec. 1974 through Dec. 1975; limnological investigations; terrestrial ecological investigations; archaeological and historical studies of the site vicinity; economic impacts of construction and operation of Coyote Station and expansion of coal handling facilities at the Beulah Mine; and an annotated list of 136 rare botanical species in the area. (LCL)

54236 (PB—266166) Topical briefs: fish and wildlife resources and electric power generation, no. 1. Final report. Boreman, J. (National Plant Power Team, Ann Arbor, Mich. (USA)). Mar 1977. 17p. NTIS, PC A02/MF A01.

This report outlines biological problems associated with power plant intake velocities. Information needed to assess impacts of intake velocities on fishery resources and a list of technical references containing more detailed analyses of the problems and mitigation alternatives are included.

54237 (PB—266167) Topical briefs: fish and wildlife resources and electric power generation, No. 2. transmission line rights-of-way management. Final report. Arner, D.H. (National Plant Power Team, Ann Arbor, Mich. (USA)). Mar 1977. 18p. NTIS, PC A02/MF A01.

Prepared by Mississippi State Univ., Mississippi State. Dept. of Wildlife and Fisheries.

Proper management of transmission line rights-of-way (ROW) to maximize benefits to fish and wildlife resources is highly desirable because a large amount of land is now preempted by these ROW, and it is anticipated that future growth of electric generating capacity will require additional large acreages of land for transmission line ROW. This paper presents some current ROW management practices and their costs, the bases for selecting a specific management technique, and some possible management goals to benefit fish and wildlife in various local situations.

54238 Kaiparowits story. Papay, L.T. pp 280-289 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

In late 1962 and early 1963 a group of western electric utilities entered into an agreement concerning the proposed Kaiparowitz coal mining and fossil-fuel power plant. In 21 months, they received water rights for up to 102,000 acre-feet of water per year from the state of Utah. Since the water was impounded in a federal area (Lake Powell) an application was made to the Bureau of Reclamation in 1965 and a federal-state dispute arose. The request was granted in 1969. Various other environmental problems requiring a different and more expensive site developed. Extremely detailed, expensive and complex environmental impact statement had to be prepared. In June, 1973 the Secretary of the Interior denied the application but, with support from Utah officials, it was announced in December, 1923 that a renewed application would be accepted. But the Bureau of Land Management's draft of the Environmental Impact Statement was only completed and submitted to the Council of Environmental Quality in July, 1975. Other problems and delays ensued and the project was cancelled. Some $20 million had been spent and the projected cost had escalated from $500 million to $3.5 billion and could not be justified. Some 58 permits and licenses had been obtained by then. (LTN)

54239 ERDA's impact assessment of power production. Goldberg, A.J. pp 290-292 of In Proceedings of a symposium on coal dilemma: how and where to use it. Denver; Cameron Engineers, Inc. (1976).

From Symposium on coal dilemma) how and where to use it; Colorado Springs, Colorado, United States of America (USA) (31 Jan 1977).

See CONF-770133—.

An attempt is made to calculate for three areas (North, Central and South Appalachia) the environmental impacts and socio-economic factors involved in the predicted increase in coal required by electric utilities from 1985 to 2000. It is predicted that the growth can take place in the North without special planning and without major changes but in the Central area and even more in the Southern area advanced planning would be necessary and major development of services and facilities and changes in life style would be required. The possible impact of two ERDA developments (fluidized-bed combustion and magnetohydrodynamic power plants) on air pollution are discussed and compared to that from conventional systems. (LTN)

THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 55531

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 53653, 53700, 53701, 53718

54240 (PB—266092) Evaluation of molten scrubbing for fine particulate control. Final report Dec 75—Feb 76. Poe, G.G.; Waterland, L.R.; Schreiber, R.J. (Acurex Corp., Mountain View, Calif. (USA). Aerotherm Div.). Mar 1977. Contract EPA-68-02-1318. 39p. NTIS PCA03/MF A01.

One important proposed use of low Btu fuel gas derived from coal gasification processes is the generation of electric power by combustion and expansion of the gas through a gas turbine. Successful operation of such a system is predicated on the conservation of sensible heat of the fuel gas. However, the raw gas from the gasification process contains impurities, notably sulfur compounds

and particulate, which are incompatible with turbine operation and must therefore be removed. Results are given of an evaluation of molten scrubbing for fine particulate control, a concept that study results indicate as seeming to be feasible. Application of the concept to fine particulate clean-up in advanced energy processes seems possible. Molten scrubbing is especially well-suited to processes where simultaneous removal of sulfur compounds is desired. However, before effective molten scrubbing systems can be developed for particulate removal, two important problems need to be solved: (1) finding construction materials at an acceptable cost which can adequately withstand the highly corrosive scrubbing medium presented by hot molten liquids; and (2) improving gas/liquid separation and mist eliminator designs so that liquid carryover satisfies emission standards or gas turbine inlet specifications. It appears that considerable development work would be required to investigate the aforementioned problems before a final assessment of the feasibility of this concept could be made.

SITE SELECTION AND LAND USE

54241 **Search for future electric generating sites.** Horton, R.S.; Ray, M.J.; Buzel, M.L.; Hadwin, T.J.; Wurmbrand, M.M. (New York State Electric and Gas, Binghamton). pp 525-532 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976).

See CONF-761016—.

Since passage of the National Environmental Policy Act, site selection has shifted emphasis from cost and engineering factors towards equal consideration of environmental values. Although federal and state guidelines require the assessment of impacts associated with power plant development, it is still a matter of judgement which considerations are included in the site selection process. However, recent regulations and opinions stress that environmental considerations be included at the earliest stages of project planning, including the selection of sites. Considering this and the often stringent public review of siting decisions during the licensing process, New York State Electric and Gas decided the best way to select a plant site is to make a comprehensive and detailed study beginning with the entire state and investigating until a small group of very good power plant sites is identified. To do this, a process was developed which reduces the area evaluated at each step while increasing the detail of the evaluations. This continuing thread of refinement and selectivity runs from beginning to end. In this way, the most favorable areas continue to be analyzed, while less desirable areas drop out along the way. This method doesn't guarantee that every good plant site is identified. But other methods don't really guarantee that either. What is assured, though, is that a number of good sites are identified and a consistent method is used to select between them.

POWER TRANSMISSION AND DISTRIBUTION

54242 (EPRI-EL—276-SR) **Symposium proceedings: new concepts in fault current limiters and power circuit breakers.** (Electric Power Research Inst., Palo Alto, Calif. (USA)). Apr 1977. 359p. (CONF-7609129—). Dep. NTIS, PC A12/MF A01.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

Nineteen papers on the design, development, and use of circuit breakers and current limiters in power systems were presented at the conference. A separate abstract was prepared for each paper. (LCL)

54243 (EPRI-EL—276-SR, pp 3.1-3.18) **Flow field effect on arcs.** Nagamatsu, H.T.; Frind, G. Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

In gas blast circuit breakers the arc extinction action near current zero depends on the cooling of the arc by the nozzle flow. Some of the flow properties important to the arc cooling process near current zero and flow velocity, static pressure, turbulence level, flow separation and shock waves. The effect of some of these flow properties on the arc have been investigated. However, detailed quantitative knowledge of the flow field phenomena interaction of the cold flow field with the arc at low current has not been reported in detail. Subsonic and supersonic cold flow fields were investigated for three nozzle geometries. The flow fields determined from static and impact pressure measurements and the shock waves and mixing the flow with the ambient air determined from Schlieren photographs. Local and mean turbulent velocities were obtained with a laser velocimeter technique. A thick oil film was used to locate the flow separation region over the upstream electrode. The throat diameter and contraction section for the convergent-divergent nozzles was held the same in order to study the effect of the nozzle expansion angle on the flow field. Specific data on flow velocity distribution, on flow separation effects, on shock waves, and on turbulent velocities was obtained: These data were used to discuss the effect of "optimum" electrode distance and observations of a diffuse arc structure in the arc interruption studies. It was found that the high observed recovery speed at "optimum" electrode wake correlates with small electrode wake and high flow velocity toward the arc. The diffuse arc structure appears to be intimately associated with the expansion process in the nozzle and shock waves. Experiments with 100 ampere dc type arc in several nozzle geometries produced the highest arc voltages in supersonic flows with the flow expanding to the nozzle exit without shock waves.

54244 (EPRI-EL—276-SR, pp 4.1-4.22) **Arc thermal recovery in different gases.** Kinsinger, R.E.; Noeske, H.O. Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

Results of experiments to compare the recovery speed (rate of rise of recovery voltage following current zero) of a variety of gases in a gas flow system are reported. A simple arc model which suggests the importance of a simple calculable gas property, the average rate of change of electrical conductivity with enthalpy density, as an indicator of recovery speed is also presented. Measurements were made of the thermal recovery speeds of a variety of gases in a single flow nozzle facility. The mathematical model for the arc in the thermal energy balance period around current zero is based on the following assumptions and approximations: cylindrical symmetry, constant and radially uniform pressure, local thermodynamic equilibrium, neglect of viscons and magnetic effects, neglect of kinetic energy density with respect to enthalpy density, and neglect of axial variations and axial convection with respect to radial variations and radial connections. Comparison of the relative recovery speeds as calculated from the arc mathematical model with those measured in the experiment provides good support for the valve of the gas property used as an indication of gas thermal recovery speed. Although other factors must be considered in a full theory of thermal interruption (i.e., power loss rate, degree of equilibrium, circuit effects) this parameter should provide some guidance in searching for new gases for arc interruption.

54245 (EPRI-EL—276-SR, pp 5.1-5.13) **Fundamental studies of arc discharges as related to power circuit breakers.** Whitman, A.M.; Cohen, I.M.; Ayyaswamy, P.S. (Univ. of Pennsylvania, Philadelphia). Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

Multi-dimensional arc modelling, the effects of convection and radiation, and both internal and circuit-coupled arc stability were studied with the objective of obtaining interruption criteria. A hyperbolic tangent function conductivity model has been verified as a good approximation against data generally accepted as reliable. Equations for conservation of energy and charge for a two-dimensional, steady, planar arc were solved for heat flux potential and electrostatic potential by a Galerkin method. Arc thickness and heat flux potential increase as current increases and as electrode temperature increases for a fixed current. These governing equations for an axially symmetric arc between hyperboloidal electrodes and stabilized by ellipsoidal walls have also been solved. Current-voltage characteristics, heat flux potential distributions, arc shapes, and heat transfer data were obtained. The blunter the cathode for a fixed gap, the larger the potential difference necessary to drive a given current. Also, the closer the bounding wall, the larger the potential difference for a fixed current. Electrode heat transfer increases with current and decreases with bluntness of the electrode. Both the constant property arc with one-dimensional electric field and the two-dimensional tanh conductivity arc with uniform axial mass flow field have been solved approximately by a Galerkin method. It was found that for a fixed current, increased blowing reduces the arc thickness, decreases the arc temperature, and increases the power necessary to sustain the arc. A simple expression was obtained for the radiative emission coefficient of argon. The stability of a one-dimensional wall-stabilized arc in a simple inductive circuit was investigated from both a linear theory (infinitesmal size disturbances) and from a minimizing solution point of view for finite size disturbances.

54246 (EPRI-EL—276-SR, pp 9.1-9.28) **Electrical breakdown in vacuum.** Farrall, G.A. Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

Electrical breakdown in vacuum is regarded as, essentially, a process dominated by the electric field at the cathode. The combined effects of electrode geometry and surface microstructure are considered as they contribute to surface electric fields. Examined particularly are some of the electrode geometries and surface microstructures which are relevant to vacuum interrupters. It is shown how these combined effects limit voltage withstand capability.

54247 (EPRI-EL—276-SR, pp 15.1-15.7) **New approach to high speed current limitation.** Pflanz, H.M.; Clark, T.F.; Albani, O.J. (Phoenix Electric Corp., Boston). Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

Inherent shortcomings of known current limiting devices, employing current commutation onto a fusible element and/or to a resistor are discussed. Thus, the lack of high operating speed and high commutation voltage requires high speed sophisticated current sensing, fault anticipation and tripping to make up for lost time. A novel, low cost, high speed pyro-cutting technique overcomes these problems. A continuous current carrying element is cut at a linear rate of $\frac{1}{4}$ inch per microsecond. A multiplicity of arc gaps with correspondingly high total arc voltage can thus be created quickly. Fast current commutation onto a fusible element is thereby accomplished. Various applications are described. Accordingly, on low voltage applications the multiplicity of arc gaps is already current limiting, while on higher voltage applications a fusible element takes over the current limiting action following current commutation. On still higher voltage applications, multiple series elements which can be typically graded by resistors are employed to achieve current limitation. High speed operation from sensing to the beginning of current limitation in less than 200 microseconds can be expected. Thus, even with relatively high current level fault sensing, low let-through can be achieved. Excellent apparatus protection with low let-through i^2t and let-through arc energies, lower than heretofore possible, becomes practical with a protective link which does not inhibit the device's ability to carry high continuous current. The device is called a current limiting protector (CLP).

54248 (EPRI-EL—276-SR, pp 17.1-17.19) **Feasibility of a vacuum arc fault current limiter.** Gilmour, A.S. Jr. (State Univ. of New York, Buffalo). Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

The feasibility of a vacuum arc fault current limiter was investigated. This work is an outgrowth of the studies on the interruption of dc vacuum arcs that have been underway for several years. In those studies a magnetic field was used to interrupt or to control the current flow in a vacuum arc device. The configuration of the device is such that electron current is forced to flow, primarily, radially outward from the end of a relatively small rod shaped cathode to a ring shaped anode. Control is achieved through the application of an axial magnetic field. For distribution circuit applications of fault current limiters, it appears feasible to limit the fault current and to absorb the energy associated with the fault current limiting process in a single vacuum arc device of the type that has been under investigation at SUNYAB. In this device, the fault current would be used to generate the axial magnetic field so that a self-limiting action would be achieved. Studies performed to date at SUNYAB have demonstrated the basic feasibility of this concept. The efforts at the present time are being directed toward increasing the voltage capability of the device. In addition, current interruption at substantial voltage and current levels is being investigated. Future efforts will be directed toward the development of compact bipolar devices.

54249 (EPRI-EL—276-SR, pp 19.1-19.17) **Protective relaying implications of fault current limiters.** Gallen, T.F. (Philadelphia Electric Co.). Apr 1977.

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

The application of fault current limiters (FCL) may prove to be the most economical solution to the problem of constantly increasing short-circuit current levels on power systems. Because fault current limiters will modify short-circuit conditions to some degree, it follows that protective relaying systems will be affected somewhat by their application. At this state in the development of FCL's, it is somewhat difficult to determine the specific effect that FCL's will have on protective relays. For one thing the exact nature of a fault current limiter has not been established. Will they be tuned circuits or switched circuit elements. Will they be resistive or inductive. For the purpose of discussion, it was assumed that FCL's are devices that switch elements into the circuit faster than the response time of protective relays and that the resulting currents are sinusoidal. A brief description of each relay scheme is presented. Overcurrent relays, directional units, differential relays and distance relays are discussed, as well as, pilot schemes for transmission line protection, such as directional comparison, phase comparison and pilot wire. The implications of installing FCL's in the vicinity of each scheme's protected zone is examined. In some instances, existing relaying systems must be replaced by alternate relay schemes. In other instances, relay protection is improved. The reaction of existing protective relays to the application of fault current limiters on power systems is considered. Relaying problems resulting from specific fault current limiter designs and applications are beyond the scope of this study. These problems must be examined carefully by relay application engineers and system designers to determine the appropriate solution.

54250 (EPRI-TD—153) **Evaluation of underground fault location techniques. Final report.** Deltenre, R.W.; Schwarz, J.J.; Wagnon, H.J. (BDM Corp., Albuquerque, N.Mex. (USA)). Apr 1976. 151p. Dep. NTIS, PC A08/MF A01.

The technical results of a study of existing and proposed underground fault location techniques are presented. The requirements for fault location and currently used techniques are described. Methods for evaluating the effectiveness and cost of these methods are discussed. Recommendations are made for designing, fabricating, and testing a prototype distribution (low voltage) fault location system and a transmission (high voltage) fault location system. (LCL)

AC SYSTEMS, EHV AND UHV

54251 (CONS/2157—1) **Impulse strength of distribution transformers under load. Final report, February 1975—September 1976.** Kaufman, G.H. (General Electric Co., Pittsfield, Mass. (USA)). Sep 1976. Contract EX-76-C-01-2157. 86p. Dep. NTIS, PC A05/MF A01.

The General Electric Company was contracted by the Energy Research and Development Administration (ERDA) under contract No. E(49-18) 2157 to study the relationship in distribution transformers between impulse strength and load current. The evaluation of the impulse strength of distribution transformers by a new test technique which simulates in-service functional conditions is described. This unique test procedure includes the effect of different load currents and of rated 60 Hz voltage stress as well as the effect of precipitation cooling. Over 50 distribution transformers with a 15 kV class insulation system were subjected to impulse breakdown tests; approximately one half of these transformers were tested in the new condition. The other half were tested after a loss of life of 50% during accelerated laboratory aging. Specimen transformers representing several USA manufacturers were purchased from five utility stockpiles. The possibility that gas bubble formation and/or accumulation within transformer windings may be a factor contributing to transformer field failures was the subject of another study described. Visual observation and dielectric measurements were made on full-size distribution transformers and on special model coils in order to establish operating conditions which resulted in bubble generation and a possible decrease in insulation breakdown strength. Other data obtained during the aging and loading of sample transformers includes: excitation and impedance losses before and after aging; winding temperatures and estimated hot spot temperatures as a function of load current; and oil characteristics before and after aging. Also described are the results of impulse tests under short-time overload conditions, and some data concerning the effect of moisture in the winding on impulse breakdown.

54252 (EPRI-EL—276-SR, pp 2.1-2.10) **ARC thermal recovery testing of gas blast interrupters.** Frind, G.; Kinsinger, R.E.; Miller, R.D.; Noeske, H.O. Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

The utility of model interrupters for thermal interruption testing and the application of the model technique to optimizing several parameters of gas blast interrupters with respect to recovery speed are discussed. The model interrupter used is a single flow dual pressure device and is used with a current injection-type synthetic circuit that can be arranged to provide different power frequencies. This test facility was used to investigate the dependence of interruption speed on the frequency of the power current. Three phenomena affecting this dependence were investigated: the strong dependence of thermal interruption speed on rate of change of current with time (I); Nozzle blocking effect that occurs when arc diameter at high

current is large enough to fill the nozzle throat; and the effect of contamination of the arc plasma by electrode (or nozzle wall) vapor. The test results showed that for the test condition identified a large variation in power frequency at a fixed I has no influence on the thermal recovery speed, if blocking is avoided. The use of this test method allowed the isolation of both the effect of electrode vapor contamination and the blocking effect from the dI/dT effect of gas blast interrupters. Electrode vapor slowed the thermal interruption speed reduced by a factor of two. Interrupter optimization experiments made in both air and SF_6 showed a strong effect of upstream electrode to nozzle distance on interruption speed. Recovery speed in air increased in a 1/2" nozzle significantly with arc length up to lengths of 2" then leveled off. Recovery speed in air with a 1/2" nozzle increased slightly stronger than linearly with the pressure up to 1100 psi.

54253 (EPRI-EL—276-SR, pp 6.1-6.17) **High density SF6 interrupters for 120 kA development.** Rostron, J.R.; Spindle, H.E. Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

The design of advanced performance interrupters is described. A 145 kV single-pressure interrupter module for the 120 kA rating was developed. The various aspects of interrupter design are separately discussed. The prior art is first reviewed with identification of additional information required to design an advanced performance interrupter. Liquid SF_6 and high pressure SF_6 gas were selected as two design approaches based upon previous experience. A power test program, design and analysis of model interrupters, and a material test program are described. These areas of investigation satisfy the most important information requirements for designing an advanced performance interrupter. First, research was done on the two approaches to provide answers to specific design questions. Materials were selected for testing, arc photographs were measured and compared, and mathematical extrapolations were made. A power test program was determined to provide the required new information to design a liquid and a gas interrupter. 100 kA bus fault tests and 80 kA SLF tests will be made with full sized model interrupters. A detailed testing program and procedure was defined for materials. Design alternatives were identified from the results of the mathematical extrapolations. A design selection was made based upon prior experience, and the most efficient interrupter design. The model interrupter designs were generated and then analyzed to verify that they would obtain the required pressure and travel conditions. The design analysis led to refining the liquid interrupter model by adding an accumulator. The analysis of the high pressure gas interrupter model verified that two available pneumatic mechanisms were adequate. These two test models will be tested alternately on the same high power synthetic test circuit for direct comparison of results.

54254 (EPRI-EL—276-SR, pp 7.1-7.12) **Technology of synchronous interruption applied to transmission breakers.** Garzon, R.D. (I-T-E Imperial Corp., Colmar, PA). Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

The basic concept of SF_6 synchronous circuit breakers is presented and the main advantages that are obtained when the synchronous approach to current interruption is utilized are emphasized. The condition where there is an absence of a current zero crossing is considered; this possibility is discussed and the probability of such an occurrence is estimated. The operating experience obtained with an earlier version of a synchronous circuit breaker, of the distribution voltage class, is briefly reviewed. The design criteria for the current zero sensor, the operating mechanism and the interrupter is given in conjunction with some data of their performance. Test methods are reviewed, and the criteria used for judging the performance of the interrupter model tested are discussed. Limits of performance established during these tests also have been discussed.

54255 (EPRI-EL—276-SR, pp 8.1-8.10) **Novel concepts of interruption for distribution and transmission circuit breakers.** Votta, G.A. (I-T-E Imperial Corp., Comar, PA). Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

Modern power circuit breakers of today tend to use vacuum or SF_6 gas as the interrupting medium instead of air or oil. Vacuum interrupters generally involve a high velocity movement of the arc whereas SF_6 type interrupters generally involve a high velocity movement of the gas relative to a quasi-stationary arc. One of the novel concepts explores the advantages of arc motion relative to a static SF_6 medium. This is accomplished with a magnetic field which is not in phase with the fault current. Each type interrupter, vacuum and SF_6, has relative advantages and disadvantages. The second novel concept explores how the series combination of SF_6 and vacuum interrupters can make use of the advantages of both types of interrupters while avoiding their disadvantages.

54256 (EPRI-EL—276-SR, pp 10.1-10.7) **Arc interruption tests on a 15 kV, 600 amp vacuum interrupter.** Mukutmoni, T. (Univ. of Texas, Austin). Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

Arc interruption tests carried out on a 15 kV, 600 amp vaccum interrupter are reported. The electrical stress during the interruption process was experimentally obtained as follows: a forward current (I_o) whose magnitude can be varied was established in the interrupter with the interrupter contacts closed; the interrupter was opened and the current is allowed to conduct through the interrupter with the contacts arcing; the current was off-commutated from the interrupter by switching-in a counter-pulse circuit; and after the "current-zero" was reached in the interrupter a forward voltage whose rate of rise (dv/dt) as well as the peak magnitude (V/ sub f/) can be varied, was applied across the interrupter. The interrupt capability of the breaker under these circumstances is described. Some of the results obtained on a vacuum interupter are discussed.

54257 (EPRI-EL—276-SR, pp 11.1-11.9) **Ratings and performance specifications for fault current limiters.** Dodds, T.H. (I-T-E Imperial Corp., Colmar, PA). Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

It is pointed out that before a fault current limiter (FCL) can be designed, built, and tested, a set of ratings and performance specifications must be established. Actual determination of what these ratings and specifications should be can itself be a difficult problem. Various problem areas in need of clarification are identified and numerous questions relevant to them are asked. The purpose in identifying these areas and asking the questions is to stimulate interest and thought and to perhaps gain some valuable information from the utility industry and other concerned parties on these matters.

54258 (EPRI-EL—276-SR, pp 12.1-12.9) **Superconducting fault current limiter.** Gray, K.E.; Fowler, D.E. Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

A conceptual design for a fault current limiter, utilizing a superconducting element to commute the fault current into a shunt resistor is presented. Technical feasibility was demonstrated by a computer simulation of the switching. A cost analysis for a 3 phase, 145 kV, 2 KA electrical system was presented along with extensions to other values of parameters. Important advantages of such a fault current limiter were pointed out and areas of additional research for the immediate future were indicated.

54259 (EPRI-EL—276-SR, pp 13.1-13.22) **Controlled impedance fault current limiter.** Paice, D.A.; Bonk, J.J. Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

The controlled impedance fault current limiter, CIFCL, includes two inductors and two capacitors in each phase. Under normal load conditions the inductor and capacitor elements appear as two series-tuned low-impedance circuits connected in parallel. Thus under normal conditions current flows readily through the CIFCL which presents essentially zero impedance. Under fault conditions the inductor and capacitor elements are switched to appear as two parallel-tuned high-impedance circuits connected in series. Thus under fault conditions current is restricted from flowing through the CIFCL which presents a very high impedance. The response is rapid, typically 0.18 cycle, and the first half cycle peak of fault current can be constrained to about 12,000 amperes peak, on a 145 kV system with capability of 121,000 amperes peak. The steady state fault current is typically controlled to about 3 times system rated current. The CIFCL can be constructed using state-of-the-art inductors, capacitors and resistors; also triggered spark gaps are

being considered to implement the switching requirements. Transient analyses have been conducted to determine circuit trade-off parameters so that optimum cost designs can be determined. Exact results encompassing worst case conditions for the components are presented in graphical form and network performance results obtained on an analog computer (ANACOM) are given. Results from a research program which covered analysis of candidate circuit techniques, cost trade offs, system coordination studies, feasibility of using triggered spark gaps and fabrication and testing of a 3-phase 10 kVA model are presented.

54260 (EPRI-EL—276-SR, pp 14.1-14.20) **Current limiting conductor.** Pflanz, H.M.; Clark, T.F.; Albani, O.J. (Phoenix Electric Corp., Boston). Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

Possible current limiting concepts are cataloged. The current limiting conductor (CLC), the inductance of which increases in response to the short circuit current, was selected because it promised simple design, repetitive operation and outstanding service reliability. The design procedure for the CLC is developed, while a module design is analyzed as to its change of inductance and optimal use of copper and steel. The nonlinear differential equations describing the electro-dynamic interaction of the CLC with the electric circuit are defined and solved by finite step integration. A peculiar beat pattern of the short circuit current was observed when considering only the inductive change currents. It was found further that this "beat" of the current was eliminated as the iron losses of the CLC and the circuit resistance increase, while the airgap of the CLC was reduced in response to the short circuit current. Thus, it is possible to reduce the first major asymmetrical loop of the prospective short circuit current by a factor of two and to transit into a near symmetrical limited current within one cycle. In this latter phase the prospective short circuit current can be reduced by a factor of 5. These transient cases are illustrated with theoretical "oscilloskетches." An experimental fractional CLC was designed, built and successfully tested at the Boston Edison Company High Power Laboratory. The theoretical current limitations were confirmed experimentally by more than 90 short circuit tests with prospective currents reaching 40,000 Ampere. These results are presented and discussed. The economics of 5 and 15 KV CLC's are projected. The highly reliable CLC promises the low risk development of full scale three phase devices by the linear extension of the low voltage fractional prototype design.

54261 (EPRI-EL—276-SR, pp 16.1-16.15) **Progress report on a switched resistor fault current limiter.** Knauer, W. (Hughes Research Labs., Malibu, CA). Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

The development status of a fault current limiter for 138 kV is described. This current limiter is capable of inserting a resistor into the faulted line approximately 1.3 ms after fault begins. Its major components are: a fault sensing unit which determines type and magnitude of the fault within about 400 μs; a mechanical switch which carries the normal line currents while closed and which can be opened in about .8 ms when a fault occurs; an electronic interrupter in parallel with the mechanical switch which carries the fault current for about 100 μs to permit deionization of the mechanical switch; and a nonlinear resistor, also connected in parallel, which carries and limits the fault current after the interrupter has been turned off. At present, these components are being fabricated and integrated into a three-phase field unit. Tests in a 138-kV substation of the AEP power system are planned for spring of 1977.

54262 (EPRI-EL—276-SR, pp 18.1-18.60) **Developmental studies of a current limiter using vacuum arc current commutation.** Kimblin, C.W.; Slade, P.G.; Gorman, J.G.; Holmes, F.A.; Emtage, P.R.; Voshall, R.E.; Heberlein, J.V.R. (Westinghouse Research Labs., Pittsburgh). Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

Investigations into the use of forced instability of vacuum arcs to insert an impedance into the line during the fault current rise are reported. The ultimate objective is to limit a fault of 45 kA r.m.s. to 20 kA r.m.s. in a 145 kV circuit. The present feasibility studies have concentrated on evaluating the use of transverse magnetic fields to force current commutation. Arcs have been established between separating electrodes in vacuum, and the factors affecting subsequent arc current commutation into a parallel resistor and parallel capacitor have been investigated at current levels to 10 kA. The experiments have been performed at low ac circuit voltages using a demountable chamber, and at ac circuit voltages of 10 kV and above using sealed devices. A high speed actuator was used, and the maximum instability current for an individual sealed device was 8.5 kA. Commutation ability was studied as a function of the magntidue of the applied transverse magnetic field, the magitude of the capacitance and resistance in parallel with the arcing device, and the electrode spacing.

54263 (EPRI-EL—276-SR, pp 20.1-20.12) **Planning for fault current limiters on electric power systems.** Evans, M.L.; Rothenbuhler, W.N. Apr 1977.

From Symposium on new concepts in fault current limiters and power circuit breakers; Buffalo, New York, United States of America (USA) (28 Sep 1969).

In Symposium proceedings: new concepts in fault current limiters and power circuit breakers.

A review of short-range plans shows several 230/69 kV substations that may require extensive changes due to an increase in the short-circuit duty on the 69 kV buses. This increase in short-circuit current results when additional 230/69 kV transformers are added to the station, when transformers are replaced with larger units, or when generation is added at the 69 kV level. The application of fault current limiters to limit the short-circuit contribution from the 230/69 kV transformers is considered as an alternate to sectionalizing the buses or changing out the 69 kV circuit breakers. A specific application of fault current limiters on the 69-kV system of the Southern California Edison Co. is discussed. In the long range, it appears that the short-circuit current for existing stations will continue to increase, resulting in a greater need for fault current limiters. In addition, it is predicted that fault current limiters will become part of an overall integrated plan of short-circuit coordination for both existing and new facilities.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

54264 (CONS/1420—1) **Superconducting cable system. Summary report, November 1971—August 1975.** Meyerhoff, R.; Moihara, H. (Union Carbide Corp., Tarrytown, N.Y. (USA)). May 1977. Contract EX-76-C-01-2077. 60p. Dep. NTIS, PC A04/MF A01.

In the opinion of EPRI and ERDA this 46 month program to develop an ac super-conducting power transmission line was unsuccessful in meeting most of its specific objectives. The technical and economic problems pursued are outlined. Unforeseen difficulties were encountered with power losses in the superconducter, eddy current losses, and heat leak. Fault current testing was never attempted. Major dielectric problems were encountered preventing operation of this system at 138 kV. Ac loss data on small samples of electroplated niobium and a preliminary cost estimate by the contractor indicated that this type of cable system might be attractive for moving large blocks of power if an overall system could be developed that would meet utility system needs. Based on R and D to date, a conceptual design was generated for the rigid conductor, rigid cryogenic enclosure, helium-spacer insulated superconducting cable system. The design parameter values that are included in this report and the cost estimate represent values that the contractor believes could be achieved with continued development; they are based on the results of full-scale laboratory tests or extrapolations from smaller scale laboratory tests. None of these values have been demonstrated to be valid in a full-scale rated power test. The test data on the voltage withstand of the dielectric spacers in pressurized liquid helium were unacceptably low, a factor of 3 to 4 below the anticipated value.

54265 (CONS/2104—1) **Resistive cryogenic cable, phase III. Final report, April 18, 1974—March 31, 1977.** (General Electric Co., Schenectady, N.Y. (USA). Power Generation and Propulsion Lab.). 1977. Contract EX-77-C-01-2104. 266p. (SRD—76-056). Dep. NTIS, PC A12/MF A01.

Work performed during 3 years of research on development of a foam-insulated underground cryogenic power transmission cable is reported. Information is included on the cryogenic envelope investigation; evaluation and aging study of electrical insulation; test system specifications; and cable system design and cost studies. (LCL)

54266 **Electric conductor consisting of superconducting single-conductors.** Penszynski, P. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,307,242/C/. 29 Jul 1976. 5p. (In German).

The invention concerns an electrical conductor, particularly for 3 phase AC transmission, with an inner conductor consisting of several superconducting individual conductors and an outer conductor concentrically surrounding the inner conductor made of individual super-conducting conductors. The individual conductors have an elliptical cross-section, where the ratio of major to minor axis is at least 3, and the major axis is at right angles to the radius of the inner

conductors. The individual conductors consist of aluminium of great purity and are provided with a covering of niobium.

54267 Process for determining faults in a section of line of an electrical supply network to be monitored. Born, E. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,339,932/C/. 26 Aug 1976. 7p. (In German).

The invention concerns a process for determining faults in a section of line of an electrical supply network to be monitored. This process uses parameters for this, which are derived from the line voltage and the line current and are taken from the line via transformers. An auxiliary voltage is formed derived from every half cycle of the line current, which determines the monitoring interval per half cycle. The fault finding is carried out in the monitoring interval, whose start follows at a time interval of at least half a cycle of the line current from the start of the previous monitoring interval. For distance measurement, a control signal is produced, if the differential voltage produced from a line voltage and from line current (according to the line drawing) passes through zero with the right polarity in the monitoring period in which the fault finding is carried out.

54268 Counter-flow cooling of a transmission line by supercritical helium. Morgan, G.H.; Jensen, J.E. (Brookhaven National Lab., Upton, N.Y. (USA)). *Cryogenics;* **17**: No. 5, 259-267(May 1977).

The task of cooling a superconducting power transmission line in which the 'go' and 'return' streams of supercritical helium are in thermal contact through the cable dielectric is examined both analytically and using an exact numerical solution to the flow equations with real helium properties. Temperature and pressure distributions are given for level and inclined terrain, an acceptable range of dielectric thermal conductivity is established, and the theoretical minimum refrigerator power is computed; the latter is compared with power computed for a real refrigerator.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 54700

54269 (P—5715) Lessons from early experience in reactor development. Allen, W. (Rand Corp., Santa Monica, Calif. (USA)). Sep 1976. 10p. (CONF-7609136—1). Corp., Santa Monica, CA.

From Workshop on institutional alternatives for breeder reactor development and commercialization; McLean, Virginia, United States of America (USA) (8 Sep 1976).

This paper deals with several issues in U.S. reactor development and demonstration experience. The focus is on the period between 1946 and 1963 during which the Atomic Energy Commission (AEC) guided early reactor research and development (R and D) and conducted the Power Reactor Demonstration Program.

54270 Design and preparation of a radioactive tracer for the investigation of solids mixing in gas-solid fluidized beds. Kolar, Z. (Interuniversitair Reactor Instituut, Delft (Netherlands)); Bohle, W. (Technische Hogeschool Twente, Enschede (Netherlands)). *Radiochem. Radioanal. Lett.;* **27**: No. 5, . 293-298(1976).

2 figs.; 2 refs.; 1 tab.

Some requirements for a tracer suitable for the study of solids mixing patterns in fluidized bed reactors are discussed. A labelling method is developed based on the adsorption from solutions by which it was possible to prepare ^{111}In (or sup(113m)In) labelled catalyst with a specific activity strictly proportional to its mass. The procedure takes about 3 hours to accomplish one experiment. Activity recoveries between 91% and 101% (average 94%) were obtained for water and 0.04M HCl with all In-concentrations with exception of aqueous solutions of carrier free material where less indium was recovered.

54271 There is no alternative. Franzen, L.F. *VDI (Ver. Dtsch. Ing.) Nachr.;* **30**: No. 40, 28(Oct 1976). (In German).

2 figs.

Since the discovery of nuclear fission in 1938, great efforts have been made in research and development for the peaceful use of nuclear power and its exploitation as a new energy source. On the one hand, nuclear reactors which already make a contribution to power supplies are regarded as the only alternative power supply for the future, on the other hand they are opposed, because the population was not sufficiently informed on this new technology and because unsolved problems or possible dangers seem unacceptable for nuclear power use. Today we are concerned with the extension of nuclear power stations, so that we are prepared for the size of tribute which may have to be paid for this advance. This article is designed to be a constructive contribution to the theme 'the extension of nuclear power'.

54272 Power generation in South Africa. van der Walt, N.T. (Electricity Supply Commission, Johannesburg (South Africa)). *Trans. S. Afr. Inst. Electr. Eng.;* **67**: No. 11, 325-331(Nov 1976).

There have been extensive developments in the power supply industry in South Africa. The most evident of these has been the increase in the size of generating units. Escom has recently placed orders for 600 MW units. In South Africa, with its large indigenous reserves of cheap coal, there was no need to rush into a nuclear power programme before it would be economic and, accordingly the first serious study of nuclear power generation was not undertaken until 1966. A final aspect of power generation which is becoming very important is the control of pollution and protection of the environment.

54273 White paper on atomic energy in fiscal 1976. *Genshiryoku Hakusho;* No. 51, 1-228(Dec 1976). (In Japanese).

Amidst the current energy stringency, the role of nuclear energy is extremely important. Nuclear power and its safety and people's understanding are the major aspects. With emphasis on the progress of governmental measures taken, the white paper as an annual report for 1976 is presented: nuclear power generation, nuclear fuel cycle, safeguards, nuclear power safety and environment preservation, advanced reactors and nuclear fusion, nuclear-powered ship, utilization of radiation, basic research, nuclear power industry, and international cooperation.

54274 Nuclear power: a special New Society survey. White, D. *New Soc. (London);* **39**: No. 756, 647-650(31 Mar 1977).

Opinion Research Centre were commissioned to carry out a special national survey into attitudes towards nuclear power. The survey was based on a representative quota sample of 1081 adults aged 18 and over, interviewed in Great Britain between 11 and 14 March 1977. The questions invited opinions concerning the building of more nuclear power stations in Britain, safety of nuclear power stations, radioactive waste disposal, the theft of plutonium to make atomic weapons, and sabotage. The results are analysed.

54275 Nuclear power and public policy. Flowers, B. *J. Br. Nucl. Energy Soc.;* **16**: No. 2, 113-121(Apr 1977).

From BNES meeting; London, UK (2 Dec 1976).

Some of the thinking behind the Sixth Report of the Royal Commission on Environmental Pollution 'Nuclear Power and the Environment', is explained by the then Chairman of the Commission, who elucidates on various sections of the report and replies to some of the criticisms which followed its publication. Attention is drawn to other recent publications concerned with the environmental risks and problems of nuclear power, particularly the report of the Fox Commission on the Ranger Uranium Environmental Inquiry, in Australia, which reached similar conclusions to those of the Royal Commission. The Fox Commission studied the problems of safeguards and proliferation in much greater detail and its opinions are quoted. In conclusion, some personal recommendations are made as to the steps which the British Government should take, in regard to safeguards, waste management and designing against sabotage and natural disasters. Dependence upon nuclear power should be reduced. Commercial fast reactor development should proceed without undue haste and on a European basis.

54276 Map of the world's nuclear power plants. *Nucl. Eng. Int.;* **22**: No. 256, posite p. 64(Apr 1977).

A pull-out wall chart is presented showing on a coloured map the locations of the world's nuclear power plants and indicating the type of reactor and number of units. The information is also included in an accompanying table which lists the stations alphabetically.

54277 Reflections on 21 years. Eklund, S. (International Atomic Energy Agency, Vienna (Austria)); Mandel, H. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.)); Teller, E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Eng. Int.;* **22**: No. 256, 25-36, 73(Apr 1977).

Personal reflections after twenty one years of nuclear power are presented by a number of those who were international figures in the nuclear energy field during that period. Lessons learnd, achievements, prospects and predictions for the future are discussed in eleven brief surveys.

54278 Review of nuclear power station achievement in 1976. Howles, L.R. (Nuclear Power Co. (Whetstone) Ltd. (UK)). *Nucl. Eng. Int.;* **22**: No. 256, 61-63(Apr 1977).

Electricity generated by nuclear power stations continued to make a steadily increasing contribution to energy supplies in many countries since the last review, in April/May 1976. Figures for electricity generated are available for all nuclear power stations in the western world for the period up to end December 1976. The changes which have taken place in their achievements during this period are studied. Various comparisons and trends are established for the four types of reactors, i.e. Magnox reactors, BWRs, PWRs and PHWR types.

54279 Quality assurance for operating nuclear power plants. Shewski, W.J. (Commonwealth Edison Co., Chicago). *Trans. Am. Nucl. Soc.;* 26: 417-418(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54280 TUV quality assurance program for the German nuclear industry. Lindackers, K.H. (TUV Rheinland, Cologne). *Trans. Am. Nucl. Soc.;* 26: 418-419(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54281 NRC lincensee-contractor vendor inspection program. Howard, E.M.; Vetter, W.E. (Nuclear Regulatory Commission, Arlington, TX). *Trans. Am. Nucl. Soc.;* 26: 419-420(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54282 Periodic technical audit of operating nuclear power plants. Harding, N.H.; Wood, K. (Associated Nuclear Services, Surrey, Eng.). *Trans. Am. Nucl. Soc.;* 26: 515-516(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54283 ENDF/B-IV fission product cross sections: absorption buildup in thermal reactors. Wilson, W.B.; England, T.R.; Stamatelatos, M.G.; LaBauve, R.J. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* 26: 592-594(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 54428, 54461, 54471, 54473, 54474, 54568, 54570, 54585, 54586, 54587, 54596, 54602, 54609, 54610, 54627, 54628

54284 (BNWL—2189) **Verification of fuel centerline thermocouple readings through response to linear power decreases.** Lanning, D.D.; Hann, C.R. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1977. Contract EY-76-C-06-1830. 54p. Dep. NTIS, PC A04/MF A01.

A method is presented whereby the true value and 95 percent confidence limits for fuel centerline temperatures are estimated from fuel thermocouple response to a linear decrease in rod power. Furthermore, it is shown that for moderate power decreases, these estimates are independent of uncertainties in the fuel rod thermal properties (including its gap conductance). The estimates are also independent of the absolute values of the initial thermocouple reading and power level. Data is presented from power decreases on the U.S. Nuclear Regulatory Commission, Battelle Pacific Northwest Laboratories assembly IFA-431 in the Halden reactor. The reactor power was linearly decreased approximately 20 percent in 30 seconds on several different occasions. The one-sided 95 percent confidence limits on centerline temperature from analysis of these runs varied from 67 to 292°C, depending on the run, the rod, and the power level. However, in 33 of the 40 cases examined, thermocouples agreed with the estimated true value centerline temperature within 80°C. Future work is recommended which could narrow the confidence limits and provide an independent measure of the fuel-to-cladding gap conductance.

54285 (BNWL-SA—5962) **GAPCON-3: a computer code to analyze the path-dependent thermal and mechanical performance of nuclear fuel rods.** Mohr, C.L.; Lanning, D.D.; Panisko, F.E.; Stewart, K.B. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1976. Contract EY-76-C-06-1830. 29p. (CONF-760997—5). Dep. NTIS, PC A03/MF A01.

From The behaviour of water reactor fuel elements under accident conditions; Spaatind, Norway (13 Sep 1976).

GAPCON-3 provides an integrated thermal and mechanical analysis of a reactor fuel pin in terms of its path-dependent power history. It is designed to handle the axial and radial variations in power, temperature, and fuel cladding mechanical interaction, normally encountered in LWR fuel. It provides detailed information regarding temperatures, stresses, and strains depending upon the mesh size selected and the needs of the user. The code uses a finite element formulation for the mechanical analysis and includes the effects of creep, plasticity, and anisotropy. The steady state thermal calculations are based upon the method of weighted residuals (MWR) and use a finite difference formulation for treating the transient thermal dependence. The fuel behavior models incorporate relocation, swelling, and densification as well as power history-dependent local fission gas release. The code is structured to operate efficiently and to allow its use in both parametric as well as detailed analysis applications. A typical problem on a CDC-6600 computer will require 8 to 10 seconds per time step for solution.

54286 (BNWL-SA—6017) **Implications of plutonium utilization strategies on the transition from a LWR economy to a breeder economy.** Newman, D.F.; Fleischman, R.M.; White, M.K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Feb 1977. Contract EY-76-C-06-1830. 13p. (CONF-770554—2). Dep. NTIS, PC A02/MF A01.

From Conference on the plutonium fuel recycle; Miami, Florida, United States of America (USA) (2 May 1977).

The plutonium interface between the LWR and LMFBR fuel cycles is examined for typical nuclear growth projections both with and without plutonium recycle in LWRs. In order to guarantee a fuel supply for projected LMFBR growth rates, significant multiple Pu recycle in LWRs will not be possible. However, about 78% of the benefit of multiple plutonium recycle between now and the turn of the century is realized by one recycle and then stockpiling spent MOX for the LMFBR. LMFBR reprocessing schecules are estimated based on accumulation of reprocessing load. These schedules are used to estimate the amount of plutonium recovered from LMFBR fuels and determine the residual LWR plutonium required to meet LMFBR demand. The stockpile of LWR produced plutonium in spent MOX is sufficient to fuel the LMFBR until commercial LMFBR reprocessing can be justified. After that time, recycle of plutonium in LWRs will be significantly limited by a continuing LMFBR demand for LWR plutonium due to the projected high LMFBR growth rate. LWR reprocessing requirements are estimated for the assumed condition that LWR plutonium recycle is not approved, but the LMFBR is still pursued as an energy option. The uncertainties presented by this condition are addressed qualitatively. However, in our judgment these uncertainties in the plutonium market would likely delay LMFBR growth to levels significantly below current projections.

54287 (NEDO—20939A) **Lattice physics methods verification.** Martin, C.L. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Jan 1977. 56p. Electric Co., San Jose, CA.

The GE Lattice Physics System was developed to be the principal reactor-physics design tool for BWR's. It has been extensively compared against experiments and has shown significant improvement over the previous design codes. This report documents many of the experimental comparisons made.

54288 Suppression of power output peak. 3-3. Naito, Y. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). pp 93-100 of In Present status and problems of reactor neutron study. Tokyo, Japan; Atomic Energy Society of Japan (1976). (In Japanese)

With the permissible maximum linear power output given, some attempt is made to minimize the power output peaking with flattened power distribution in order to raise power output density. The means of suppressing radial and axial power output peaking factors and local power output peaking factor for LWRs are described. The method is essentially through the proper arrangement of fuel, absorber and moderator which constitute the reactor core. The local peaking factor concerns the water gaps after control-rods are withdrawn around fuel assemblies.

54289 Qualifications of class 1E cables for nuclear power generating stations. Oda, E.; Uchida, K.; Fujimura, S.; Ohya, S. (Furukawa Electric Co. Ltd., Tokyo (Japan)). *FAPIG (Tokyo);* No. 81, 48-56(May 1976). (In Japanese).

The cables of class 1E used for nuclear power stations have been strictly required to be flame retardant. IEEE Standard 383 has been instituted for such cables, which mainly requires the radiation resistance test and the pressure and temperature resistance test for the simulation of loss of coolant accident, and firing test with the cables hanged to vertical trays. Though these tests are slightly different for PWR, BWR and HTGR, the requirements are explained in detail. The firing test on vertical trays aims at, in short, the judgement on the degree of propagating fire and of self extinction when the fire source is removed. The judgement does not include the damage in outer sheaths and insulators. The recent trend indicates the transition of cross-linked polyethylene and ethylene propylene rubber to flame-retardant polyethylene and ethylene propylene rubber in insulator materials, and the change of polyvinyl chloride to low-hydrochloric acid vinyl and glass fibre or asbestos braid to chloroprene braid in sheath materials. Intention to employ the flame retardant materials for supports and holding tapes is also presented.

54290 Development of light water type power reactor in Japan. Takahashi, H. (Ministry of International Trade and Industry, Tokyo (Japan)). *Genshiryoku Kogyo;* **22**: No. 6, 35-42(Jun 1976). (In Japanese).

As for the nuclear power generation in Japan, 12 reactors, 6600 MW, are in operation, and 16 reactors, 14190 MW, are under construction or in preparation. Since the oil crisis, the expectation of nuclear energy is large in Japan which lacks of energy resources, and as the target of the development, 49000 MW at the end of 1985 was shown. Light water reactors were developed in U.S. and imported into Japan. Effort has been exerted to learn the technologies and the domestic production of the reactors was projected. For the time being, the light water reactors are the mainstay of nuclear power generation in Japan, accordingly in order to improve the safety and reliability, it is necessary to get rid of technical dependence on foreign countries and to establish the technologies of light water reactors suitable to Japanese situations by accelerating improvement and standardization on the basis of the independent development. The power output of standard nuclear power plants is 800 MW and 1100 MW.

54291 Operating experience. Reports from world nuclear power station sites. *Nucl. Eng. Int.;* **22**: No. 256, 64-67(Apr 1977).

In this second section of reports from the world's nuclear power station sites, a very brief summary is given of experience gained from stations which have been in commercial operation and those recently commissioned. The reactors, which are listed under country, included: Pickering NGS-A, Phenix, Rapsodie, Obrigheim, Brunsbuettel, Biblis B, Wuergassen, Gundremmingen, Stade, Rajasthan, Takahama 1 and 2, Mihama 1, Mihama 2, Tokai 2, Tsuruga, Borssele, Muehleberg, Prototype Fast Reactor, Hinkley Point B, Hunterston A, Hunterston B, Port St. Vrain, Pilgrim, San Onofre-1.

54292 Maintenance outrage management at Commonwealth Edison. Wandke, N.E. (Commonwealth Edison Co., Chicago, Ill. (USA)). *Nucl. Eng. Int.;* **22**: No. 256, 55-57(Apr 1977).

The method of outage maintenance for the Commonwealth Edison nuclear power stations is described. The main principles of procedure are discussed and are then illustrated by application to the Dresden-3 reactor. The key elements considered are organisation, planning, assignment of responsibility, communication, schedule and budget control.

54293 Oxygen monitoring and control in BWR plants. Pearl, W.L.; Kassen, W.R.; Sawochka, S.G. (Nuclear Services Corp., Campbell, CA). *Trans. Am. Nucl. Soc.;* **26**: 429-430(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54294 Water chemistry characterizations of the boiling water reactor. Miller, A.D. (General Electric Co., San Jose, CA); Burley, E.L.; Snyder, D.T.; Selby, K.A. *Trans. Am. Nucl. Soc.;* **26**: 430-431(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54295 BWR multirod critical power reproducibility tests at different facilities. Matzner, B. (General Electric Co., San Jose, CA); Eklund, R.; Nylund, O. *Trans. Am. Nucl. Soc.;* **26**: 465(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54296 Gap conductance in reactor fuel elements. Loyalka, S.K. (Univ. of Missouri, Columbia). *Trans. Am. Nucl. Soc.;* **26**: 466-467(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54297 CASMO: a fast transport theory assembly depletion code for LWR analysis. Ahlin, A.; Edenius, M. (AB Atomenergi, Nykoeping, Sweden). *Trans. Am. Nucl. Soc.;* **26**: 604-605(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 54284, 54285, 54286, 54288, 54289, 54291, 54296, 54297, 54422, 54427, 54461, 54462, 54471, 54473, 54474, 54509, 54510, 54512, 54516, 54524, 54568, 54569, 54570, 54571, 54574, 54583, 54604, 54609, 54610, 54618, 54620, 54621, 54622, 54623, 54624, 54625, 54628, 54635

54298 (BNL-NUREG—22652) Inelastic analysis of finite length and depth cracked tubes. Reich, M.; Prachuktam, S.; Gardner, D. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 12p. (CONF-770807—16). Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

Steam generator tube failure can at times result in reactor safety problems and subsequent premature reactor shutdowns. Typical PWR steam generator units contain thousands of long straight tubes with U-bend sections. These tubes are primarily made from alloy 600 and their sizes vary between $^{3}/_{4}$" and $^{7}/_{8}$" (1.905 cm and 2.223 cm) in diameter with nominal thicknesses of 0.043" to 0.053" (0.109 cm to 0.135 cm). Since alloy 600 (and the previously used 304-SS tubes) are ductile, high toughness materials LEFM (linear elastic fracture mechanics) criteria do not apply. This paper concerns itself with the prediction of the failure pressures for typical PWR steam generator tubes with longitudinal finite length and finite depth cracks. Only local plastic overload failure is considered.

54299 (CONF-760822—P1, pp 432-446) Operating experience with the testing of iodine adsorbers on the air clean up systems of the Belgian PWR power plants. Deckers, B.; Sigli, P.; Trehen, L. 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The in situ test method of iodine adsorbers used in France and Belgium has been developed by the French Atomic Energy Authority (CEA). Iodine 131 (in the form of elemental iodine or as methyl iodide) is injected in the ventilation duct up-stream to the adsorber; the filter decontamination factor (DF) is derived from up-stream and down-stream samplings. The main results obtained on Belgian plants are given considering two view points: acceptance of the installation and periodic testing. The results obtained are discussed in terms of: comparison of DF obtained by in situ and by laboratory measurements on activated carbon samples; effect of air flow rate and relative humidity of the air flow through the adsorber; determination of ventilation air flow from measurement of injected versus retained iodine as a possible cross check; and ageing of tested adsorbers.

54300 (CONF-760822—P2, pp 761-783) Standardization of air cleanup systems for nuclear powerplants. Nicolaysen, E.; Carey, K.E.; Wolak, J.J. (Gibbs and Hill, Inc., New York). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The Gibbs and Hill, Inc. (G and HI) approach to standardization of the air cleanup systems serving the controlled access areas in pressurized water reactor (PWR) powerplants was developed in the course of designing a succession of powerplants including Fort Calhoun Unit 1, Angra Unit 1, C.N. Almaraz Units 1 and 2, Comanche Peak Units 1 and 2, Fort Calhoun Station Unit 2 and the G and H standard plant. The G and HI designs emphasized operability, maintainability, quality, testability, redundancy, constructability, and operation convenience at minimum cost. The later designs have been strongly influenced by Nuclear Regulatory Commission (NRC) Regulatory Guide 1.52. All designs have, to some extent, been influenced by conditions related to the geographical locations of the stations. The relationship and interplay of these factors is illustrated by discussions of the Comanche Peak Units 1 and 2, Fort Calhoun Station Unit 2, and the G and HI standard plant designs. The standard plant complicated the system design by requiring a design that can be built on a variety of sites. The design innovations to standardize the air-filtration system necessitated by this requirement are discussed.

54301 (ORNL-tr—4375) Release of fission products by a rod with a manufacturing defect (BREAK). The BOUFFON 08 J 4 experiment. Chenebault, P.; Kurka, G. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Metallurgie). Oct 1975. Translation by S.D. Blalock Jr. of DR—60/75. 29p. Dep. NTIS, PC A03/MF A01.

The BOUFFON 08 experiment consisted of the circuit irradiation in the Siloe reactor of the thermosiphon and the 15 x 15 type rod with a seal defect simulating a faulty solder (weld). The condi-

tions of power, temperature, and pressure were typical of PWR conditions. The fission products released by the faulty rod and the presence of a water cooling circuit have been analyzed using samples. The γ-activity was essentially due to the volatile fission products; it progressively increased over the course of 25 days of irradiation by the rod and reaches 30 to 35 curies per kW of nuclear waste. Over the course of the test, the activities radiated by the tube circuits were one to two orders higher than those that uniquely correspond to the nuclides that were present in the water: the iodine and noble gases were deposited on the walls and this deposit was continuously resupplied by the circulating water. At the end of irradiation, secondary ruptures were apparent at the level of the fuel; these were revealed by a gross increase in the concentrations of solid fission products and by the abnormal distribution of radioactive nuclides in the fuel.

54302 Reliability techniques in assessment of nuclear reactor safety. Carnino, A. (Commissariat a l'Energie Atomique, Brussels (Belgium)). pp 83-91 of In Generic techniques in systems reliability assessment. Henley, E.J.; Lynn, J.W. (eds.). Leyden, The Netherlands; Noordhoff International (1976).

From NATO Advanced Study Institute on generic techniques in systems reliability assessment; Liverpool, UK (17 - 28 Jul 1973).

Reliability methods allow one to perform a functional and logical analysis of various reactor systems; then follows a deep investigation about the equipments and their failure risks. With appropriate reliability data, it is possible to assess with a sufficient accuracy the probability of failure of the systems and then the probability of an accident.

54303 Digital simulation for nuclear once-through steam generators. Chen, A.T. Knoxville, TN; Univ. of Tennessee (1976). 266p. University Microfilms Order No. 77-10,757.

Thesis (Ph. D.).

Mathematical models for calculating the dynamic response of the Oconee type once through steam generator (OTSG) and the integral economizer once through steam generator (IEOTSG) was developed and presented in this dissertation. Linear and nonlinear models of both steam generator types were formulated using the state variable, lumped parameter approach. Transient and frequency responses of system parameters were calculated for various perturbations from both the primary coolant side and the secondary side. Transients of key parameters, including primary outlet temperature, superheated steam outlet temperature, boiling length/subcooled length and steam pressure, were generated, compared and discussed for both steam generator types. Frequency responses of delta P/sub s//deltaT/sub pin/ of the linear OTSG model were validated by using the dynamic testing results obtained at the Oconee I nuclear power station. A sensitivity analysis in both the time and the frequency domains was performed. It was concluded that the mathematical and computer models developed in this dissertation for both the OTSG and the IEOTSG are suitable for overall plant performance evaluation and steam generator related component/system design analysis for nuclear plants using either type of steam generator.

54304 Thin wall welded titanium tubes for turbine condenser and heat exchanger. Ito, H. (Kobe Steel Ltd. (Japan)). *FAPIG (Tokyo);* No. 81, 32-39, 56(May 1976). (In Japanese).

In Great Britain, France and Italy, the intention of using titanium tubes totally for the condensers cooled with sea water in nuclear power stations and securing tight, leakless condensers is expressed. Especially in PWR nuclear power stations, the operation of leakless condensers can eliminate expensive condenser demineralizer, and it is also connected to the measures of preventing secondary corrosion on the heating tubes of steam generators. In Japan, welded titanium tubes have been used as the measures to ammonia attack in the air-cooled zone of condensers, but recently, the significance of constructing all titanium condensers is recognized in the aspect of environment preservation. Thin walled, welded titanium tubes can endure polluted sea water corrosion, deposit attack, sand erosion and biofouling, and high flow velocity of sea water can be used. The physical and mechanical properties of titanium tubes are compared with those of aluminum brass, 7/3 cupronickel and SUS 316 steel. Titanium tubes were examined carefully regarding buckling and vibration because they are very thin as compared with copper alloy tubes. They are sufficiently safe to buckling, and the distance of supporting plates must be somewhat shorter to avoid the resonance with rotating machines. Cathodic protection is required when titanium tubes are fixed on copper alloy tube plates.

54305 Development of nuclear power and the resolutions of the XVth Congress of the Communist Party of Czechoslovakia and of the XXVth Congress of the Communist Party of the Soviet Union. Neumann, J. (Ceskoslovenska Komise pro Atomovou Energii, Prague). *Tech. Pr.;* **28**: No. 7, 26-29(Jul 1976). (In Czech).

The prospects of the development of nuclear power production in Czechoslovakia and in the other countries of the Council of Mutual Economic Assistance are analyzed. The preparedness of the Czechoslovak industry for fulfilling the demanding tasks of building nuclear power plants with WWER type reactors is evaluated. Attention is also devoted to preparations for the industrial manufacture of components for nuclear power plants with fast reactors and possibilities for the use of the thermonuclear reaction for power production.

54306 Hybrid simulation of a nuclear fuel and electric heater pin. Maslo, R.M. (Electronic Associates, Inc., West Long Branch, N.J., USA); Hyer, F.K. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). pp 795-803 of In Simulation of systems. Proceedings of the 8th AICA congress, Delft, 23-28 Aug 1976. Dekker, L. (ed.). Amsterdam, The Netherlands; North-Holland (1977).

From 8. AICA congress on simulation of systems; Delft, Netherlands (23 - 28 Aug 1976).

The application of hybrid simulation techniques in the design of a electrically heated fuel element is presented. Simulation was used to insure that the electric heater pin had the same transient characteristics as a typical nuclear fuel pin as is used in a pressurized water reactor.

54307 Void fraction and incipient point of boiling during the subcooled nucleate flow boiling of water. Unal, H.C. (Nijverheidsorganisatie TNO, Apeldoorn-Zuid (Netherlands). Centraal Technisch Instituut TNO). *Int. J. Heat Mass Transfer;* **20**: No. 4, 409-419(Apr 1977).

Void fraction has been determined with high-speed photography for subcooled nucleate flow boiling of water. The data obtained and the data of various investigators for adiabatic flow of steam-water mixtures and saturated bulk boiling of water have yielded a correlation is estimated to be 27.5,. which covers the following conditions: geometry: vertically orientated circular tubes, rectangular channels and annuli; pressure: 2 to 15.9 MN/m^2; mass velocity: 388 to 3500 kg/m^2s; void fraction: 0 to 99%; hydraulic diameter: 0.0047 to 0.0343 m; heat flux: adiabatic and 0.01 to 2.0 MW/m^2. The accuracy of the correlation is estimated to be 12.5%. The value of the so-called distribution (or flow) parameter has been experimentally determined and found to be equal to 1 for a vertical small-diameter circular tube. The incipient point of boiling for subcooled nucleate flow boiling of water has been determined with high-speed photography. The data obtained and the data available in the literature have yielded a correlation which covers the following conditions: geometry: plate, circular tube and inner tube-heated, outer tube-heated and inner - and outer tube heated annulus; pressure: 0.15 to 15.9 MN/m^2; mass velocity: 470 to 17355 kg/m^2s; hydraulic diameter: 0.00239 to 0.032 m; heat flux: 0.13 to 9.8 MW/m^2; subcooling: 2.6 to 108 K; material of heating surface: stainless steel and nickel. The accuracy of the correlation is estimated to be 27.5%.

54308 Designing for easy maintenance in Germany. Eitz, A.W.; Wahl, D.J. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.)). *Nucl. Eng. Int.;* **22**: No. 256, 52-55(Apr 1977).

The approach of RWE in designing for simpler maintenance and reliability for nuclear power systems and components is considered. Procedures used in planning, erection and start-up of Biblis A are described. Delays encountered with both Biblis A and Biblis B are discussed.

54309 Response of fluid-elastically coupled coaxial cylindrical shells to external flow. Au-Yang, M.K. (Babcock and Wilcox, Lynchburg, VA). *J. Fluids Eng.;* **99**: No. 2, 319-324(Jun 1977).

The dynamics of a system of two fluid-elastically coupled coaxial cylindrical shells is studied theoretically. The general equations of motion for free and forced-damped vibration are derived in terms of virtual mass, coupling coefficients, and uncoupled natural frequencies of the individual cylindrical shells. For free vibration, numerical solutions to the coupled equations of motion are given as a function of these parameters. For forced-damped vibration, solution is given to the special case when the external force is a normal one acting on the surface of the outer shell, such as the dynamic pressure forces arising from an external turbulent axial flow. It is shown that the coupled system can then be reduced to an equivalent single cylindrical shell. However, the effective force acting on the equivalent single cylinder, as well as its natural frequencies and effective damping ratios, are all modified from the corresponding uncoupled values. The response of the system can then be predicted by established methods in flow-induced random vibration analysis. Curves are included. The study aims mainly at applications to the vibration analysis of hydraulically coupled internal components of a pressurized nuclear reactor but is general enough to find application in other engineering disciplines.

54310 Floating nuclear plants: a general overview. Mittl, R.L.; Brandt, F.W. (Public Service Electric and Gas Co., Newark, NJ). *Trans. Am. Nucl. Soc.;* **26**: 421(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54311 Manufacture of floating nuclear power plants. Turner, J.E. Jr. (Offshore Power Systems, Jacksonville, FL). *Trans. Am. Nucl. Soc.;* **26**: 421-422(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54312 Update of operations with Westinghouse steam generators. Malinowski, D.D.; Fletcher, W.D. (Westinghouse Electric Corp., Pittsburgh). *Trans. Am. Nucl. Soc.;* **26**: 425(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54313 Operating experience of Babcock and Wilcox nuclear steam supply system. Bell, M.J.; Sherburne, P.A. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.;* **26**: 425-426(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54314 Control of ^{59}Co dissolution during refueling shutdowns of PWRs using hydrogen peroxide addition. Kormuth, J.W. (Westinghouse Electric Corp., Pittsburgh). *Trans. Am. Nucl. Soc.;* **26**: 426-429(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54315 Steady-state thermal analysis of PWRs by a simplified method. Moreno, P. (Massachusetts Inst. of Tech., Cambridge); Liu, J.; Khan, E.; Todreas, N. *Trans. Am. Nucl. Soc.;* **26**: 465-466(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54316 Iodine spiking phenomenon in pressurized water reactor coolants. Chubb, W.; Piplica, E.J.; Lutz, R.J. (Westinghouse Electric Corp., Pittsburgh). *Trans. Am. Nucl. Soc.;* **26**: 517-518(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54317 Temperature sensitivity of cobalt self-powered neutron detectors under PWR conditions. Allison, C.M.; Quapp, W.J. (EG and G Idaho, Inc., Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* **26**: 524(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54318 Extended inverse kinetics for monitoring reactor feedback parameters. Rozek, T.J. (Combustion Engineering, Inc., Windsor, CT); Kerlin, T.W. *Trans. Am. Nucl. Soc.;* **26**: 536-537(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54319 SNUPPS: an experience in standardization of nuclear power plants. Kanga, B.K. (Bechtel Power Corp., Gaithersburg, MD). *Civ. Eng. (N.Y.);* **47**: No. 7, 47-50(Jul 1977).

The Standardized Nuclear Unit Power Plant System (SNUPPS) is the first successful attempt by a group of utilities at standardization of nuclear power plants in the United States. It is a project for building five identical units, in four different states, by a group of five utilities. With design engineering and procurement of equipment and materials being sixty percent complete and construction work started at two of the four sites, the project is well along in successful standardization. This article outlines the approaches and methods used in successful standardization.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 54291, 54441, 54672, 54806, 54863

54320 Keynote address: influence of chemical environment on high-temperature mechanical properties. Gibbs, G.B. (Central Electricity Generating Board, Berkeley, Eng.). pp 11-20 of In Physical metallurgy of reactor fuel elements. Harris, J.E. (ed.). London; Metals Society (1975).

From International conference on physical metallurgy of reactor fuel elements; Berkeley, England, UK (2 Sep 1973).

See CONF-730912—.

The influence of chemical environment on high-temperature mechanical properties is examined for structural and cladding materials used in gas-cooled and sodium-cooled nuclear reactors. Particular attention is given to phenomena associated with oxidation, surface depletion of solute elements, carburization, and decarburization. Behaviour is shown to be sensitive to the oxygen potential of the environment. Most metallic elements oxidize in air, CO_2-based coolants, and steam, giving complete surface coverage with oxide scale. In HTR helium and FBR sodium coolants, the effective oxygen partial pressure is low. Selective oxidation of particular elements occurs, and there is often incomplete surface coverage with scale. This facilitates transport of elements to and from reactor alloys, particularly carbon. Metal oxidation can produce mechanical strengthening or weakening effects, depending on the oxidizing conditions, metallurgical condition of the substrate, and the strain rate. Carburization strengthens but embrittles affected surface layers; decarburization and solute leaching have weakening effects. The importance of the various phenomena depends on the size of the surface reaction zone in relation to the cross-section of the component or test specimen. The thermodynamic principles governing coolant attack may be applied also to reactions of fuel cladding with oxygen and fission products released from the fuel, although these reactions are complicated by irradiation effects. Various embrittling processes have been identified.

54321 Metallurgical problems of the He-to-He heat exchanger for advanced HTR's. Huddle, R.A.U. (Commission of the European Communities, Petten (Netherlands). Joint Nuclear Research Center); Fricker, H.W. (Sulzer Bros. Ltd., Winterthur (Switzerland)). *Rev. Int. Hautes Temp. Refract.;* **13**: No. 4, 212-216(1976).

From 1. Petten colloquium on advanced high temperature material: technological and industrial aspects; Petten, Netherlands (29 - 30 Jan 1976).

An attempt is made to assess the need for an intermediate heat exchanger, to indicate the nature of the problems involved, and to discuss the metallurgical problems to be studied if appropriate alloys are to be developed. If the estimates given are realistic it would suggest that a major effort to eliminate the intermediate heat exchanger is desirable.

54322 Tamokuteki koon gasuro kenkyu kaihatsu no genjo, 1976 nen. (Present status of research and development of a multi-purpose high-temperature gas cooled reactor in JAERI (1976 edition)). Tokyo, Japan; Japan Atomic Energy Research Inst. (1976). 82p. (In Japanese).

Research works in JAERI, mainly in the past year, on the development of a multi-purpose high-temperature gas cooled reactor, are described with emphasis on the experimental one being designed at present: design study, coated fuel particles, structural graphite, heat-resisting metals, heat transfer, engineering, and irradiation tests. Features of the experimental gas cooled reactor are heat output 50 MW, outlet gas temperature 1,000°C, coated UO_2 fuel particles in graphite blocks and two loops of coolant with intermediate heat exchangers.

54323 (GERHTR—165) Study of particle movement in conical fluidized beds using the tracer method. Penkalla, H.J.; Gyarmati, E.; Nickel, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jan 1976. Translation of JUL—1266. 113p. Dep. NTIS, PC A06/MF A01.

Work performed under United States—German High Temperature Reactor Research Exchange Program.

In the work reported here, a method is described which enables the path and speed of the particles during fluidization to be measured using a tracer particle technique. Using statistical methods, it is then possible to determine the path-time diagram, the rate of circulation of the particles, the transport capacity, the extent of mixing and the relative residence time of the particles in a given zone of the bed. Measurements were made at room temperature in a 3" model fluidized bed as a first step in evaluating the feasibility of the test method. Criteria for the type of coating, the growth rate of the coatings and the coating potential of the coating as were correlated with the relative dwell time of the particles and the dwell-time spectrum of the coating gases in a given part of the bed. It was therefore necessary to know the streaming behavior of the fluidizing gas, and so such an analysis was first carried out.

54324 Gas-cooled nuclear reactor. Brandes, S.; Huebner, A. (to Hochtemperatur-Reaktorbau G.m.b.H). German(FRG) Patent 2,451,749/A/. 13 May 1976. 17p. (In German).

5 figs.

In a gas-cooled, graphite-moderated pebble-bed reactor with inserted absorber rods, a high concentration of the thermal neutron flux is found in the outer core and in the lateral reflector. According to the invention, this is avoided and additionally a flat distribution of neutron flux over the reactor cross-section is achieved if the absorber rod density over the cross-sectional area of the core increases from the center to the edge of the core. This may be achieved by reducing the lattice raster or by decreasing the distance between the

rods arranged on the outer absorber rod rings. Further possibilities for changing the density of occupancy are the subject of this claim.

54325 Finite element creep buckling analysis of shallow spherical shell. Yagawa, G.; Miyazaki, N.; Ando, Y. (Tokyo Univ. (Japan). Faculty of Engineering). *Nippon Kikai Gakkai Rombunshu;* **42**: No. 359, 2015-2024(Jul 1976). (In Japanese).

The thin wall structures subjected to the continuous load not exceeding the static critical buckling load may buckle after the lapse of critical time by the effect of creep. Recently, for the design of high temperature reactors, the creep buckling analysis of the structures of complex shapes is required as prescribed in ASME Boiler and Pressure Vessel Code, Section 3. The creep buckling analysis of partial spherical shells up to the moment just before buckling with the program for axially symmetric thin-walled shells was reported in the previous paper by the authors. In this study, the analysis was extended to after buckling, and elasto-plastic creep buckling analysis was carried out. The creep buckling phenomena of partial spherical shells fixed at the periphery and subjected to uniform outside pressure were clarified by the analysis. As the results, it was found that the mode of static elastic buckling of partial spherical shells was hopping buckling, and that the outside pressure had to exceed a certain critical value to cause the hopping buckling by creep. From the result of the creep buckling analysis taking plastic properties into account, it was found that the extension of plastic region largely contributed to cause the hopping buckling by creep.

54326 First stage conceptual design of the experimental multi-purpose high temperature gas cooled reactor. Kobayashi, Y.; Izaki, T.; Hayashi, S.; Iino, T.; Ueno, Y. (Kawasaki Heavy Industries Ltd., Kobe (Japan)). *Kawasaki Giho;* No. 61, 9-15(Aug 1976). (In Japanese).

This paper describes the first stage conceptual design of the experimental multi-purpose high temperature gas cooled reactor, the design study carried out under contract to the Japan Atomic Energy Research Institute in fiscal year 1974. It was conducted by the collaboration of four domestic nuclear industry groups, with the First Atomic Power Industry Group (FAPIG) as the main contractor. This design study was carried out on the basis of the preliminary conceptual design of the reactor which was finished in the preceding fiscal year. Emphasis was placed on the system design and the structural design of the main components, followed by a more detailed evaluation of structural integrity. Summarizing the design study which is expected to provide useful information for use in establishing guidelines for the next design stage, this paper describes the outline of the reactor plant and some design features.

54327 Method of manufacturing prismatic block-shaped fuel elements for high-temperature reactors. Huschka, H.; Herrmann, F.J. (to Nuklear-Chemie und -Metallurgie G.m.b.H). German(FRG) Patent 2,208,855/C/. 7 Oct 1976. 7p. (In German).

2 figs.

Prismatic block-shaped fuel elements for high-temperature reactors with cylindrical bores for incorporation of nuclear fuel inserts (consisting of coated fuel particles and graphite matrix) often have a gap between graphite block and fuel insert inhibiting heat transfer. According to the invention this can be avoided if the heat-treatment of the pressed fuel insert is applied only after the insert is already placed in the bore of the graphite block. In addition, the composition of the graphite powder is chosen so that after heat treatment, the gap between cylindrical bore and fuel insert required for filling has disappeared and no new gap will form during operation of the reactor. It is of advantage if the graphite pressing powder consists of natural graphite with about 15% binder shares.

54328 (ORNL-tr—4358) **Working program for 1977—1979.** (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). Mar 1977. Translation of HTB-IB—1/77. 31p. Dep. NTIS, PC A03/MF A01.

The further development of spherical fuel elements with improved retention of fission products, and their testing under loads which occur in the core of the PNP reactor, as well as the preparation and selection of suitable German graphite for the PNP reflector, are the focal points of the HTB working programs. Particle development, fuel element development, and graphite development are described.

54329 Magnox availability increasingly vital to Britain. Brown, V. (Central Electricity Generating Board, Gloucester (UK). Oldbury Nuclear Power Station). *Nucl. Eng. Int.;* **22**: No. 256, 50-52(Apr 1977).

Britain's nine Magnox stations are producing more electricity more cheaply than the country's oil-fired stations. Continuing to achieve 75% load factors with ageing plant raises special problems and underlines the importance of a skilled station staff capable of initiating solutions and obtaining licensing approval. Each reactor is examined biennially. The replacement of corroded cable clips on the thermocouple cable assembly at Oldbury is described to illustrate how component failures have been rectified by station staff. The almost negligible failure rate of the Magnox fuel elements also illustrates how these stations maintain and enhance productivity.

54330 Oxidation of carbon monoxide in nuclear reactor coolants. Gliddon, B.J.; Hotchkiss, R.C.; Roberts, R.A. (Central Electricity Generating Board, Southampton (UK). Marchwood Engineering Labs.). *J. Br. Nucl. Energy Soc.;* **16**: No. 2, 143-151(Apr 1977).

Carbon monoxide in AGR and some Magnox circuits is oxidized catalytically in order to control its concentration. Experiments to determine the form of the rate expression and the magnitudes of the catalyst rate constants are described. The oxidation rates for both platinum and palladium catalysts were found to obey an expression postulated by Langmuir [(r = k(Po$_2$/Psub(CO))]. Both chemical kinetics and gas film diffusion influence overall oxidation rates under AGR operating conditions. An expression which allows for combined chemical and diffusional rate control is derived to predict recombination unit performance.

54331 Development and current status of emergency monitoring procedures at CEGB nuclear power stations. Macdonald, H.F.; Ballard, P.J.; Thompson, I.M.G. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.); Goldfinch, E.P.; Orchard, H.C. (Central Electricity Generating Board, London (UK). Nuclear Health and Safety Dept.). *J. Br. Nucl. Energy Soc.;* **16**: No. 2, 177-186(Apr 1977).

The development of comprehensive computer models describing the complex route from source to man has enabled detailed studies of the environmental consequences of hypothetical reactor accidents to be undertaken. The early development of emergency monitoring procedures at CEGB nuclear power stations is outlined, and the recent application of computer techniques in order to introduce improvements in the established procedures is discussed.

54332 Future of the high temperature reactor. Shepherd, L.R. *J. Br. Nucl. Energy Soc.;* **16**: No. 2, 123-130(Apr 1977).

Lecture sponsored by the British Nuclear Energy Society and given at the Institution of Civil Engineers, 18 November 1976.

The characteristics of the high temperature reactor which, in combination, lead to a high degree of safett and also to considerable development potential are described. The very satisfactory experiences gained from Dragon, Peach Bottom and the AVR pebble bed reactor, particularly in relation to helium technology, graphite core structure and fission product retention in coated fuel particles are discussed in some detail. Future prospects considered are the use of commercial steam cycle HTRs, the gas turbine HTR and the possible use of process heat. The medium and long-term role of HTRs is finally examined.

54333 Space shielding cross sections for pebble-bed high-temperature reactors. Stamatelatos, M.G.; LaBauve, R.J. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 600-601(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

54334 Development of the refueling machine for 'FUGEN'. Yukishima, I. (Fuji Electric Co. Ltd., Kawasaki, Kanagawa (Japan). Kawasaki Factory). *FAPIG (Tokyo);* No. 81, 2-10(May 1976). (In Japanese).

The advanced thermal reactor fugen is designed so that the fuel can be exchanged during the operation of the reactor, aiming at the high rate of operation and the fuel cycle of plutonium self-sustaining type. The refueling machine takes out or inserts the fuel assembly through the bottom of the pressure tube, and spent fuel is transferred to the fuel exchange pool installed in the containment vessel, then the machine accepts new fuel here. The spent fuel is discharged from the fuel exchange pool, through the transfer chute penetrating obliquely the containment vessel, to the fuel-storing pool outside. New fuel is transferred to t through the reversed procedures. The operation of the machinery within the containment vessel and those concerning the transfer chute is carried out remotely from the central control room by computer control.

54335 Application of a feedback control system in Switzerland. Haelg, R.; Kueffer, K. (Nordostschweizerische Kraftwerke A.G., Baden). *Nucl. Eng. Int.;* **22**: No. 256, 57-60(Apr 1977).

The benefits of applying the lessons of experience are shown in the improved availability of Beznau I and the even better performance of Beznau II. An important factor has been the use of a system of feedback control and attention to staff motivation through dynamic management. Improvements should, however, be made in small steps and alternatives realistically evaluated.

54326 **Optimising personnel and equipment performance at Ontario Hydro.** Anderson, D.R. (Ontario Hydro, Toronto (Canada)). *Nucl. Eng. Int.;* 22: No. 256, 45-50(Apr 1977).

In recent years the CANDU-PHW units of Ontario Hydro have demonstrated that high productivity can be achieved in nuclear power stations. Among the factors that have helped have been sound basic design, effective management, good operating practice and commitment to a consistent maintenance strategy. In addition importance is attached to the setting and monitoring of quantified performance objectives.

54337 **Nuclear fuel bundle design with reduced void effect.** Roshd, M.H.M.; French, P.M.; Jones, R.T. (Atomic Energy of Canada Ltd., Chalk River, Ontario). *Trans. Am. Nucl. Soc.;* 26: 603-604(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 54286, 54320, 54450, 54463, 54511, 54576, 54577, 54578, 54579, 54580, 54581, 54584, 54605, 54606, 54614, 54626, 54631, 54632, 54633, 54673, 54771, 54777, 54798

54338 (BNL-NUREG—50650) **Compilation of references, data sources and analysis methods for LMFBR primary piping system components.** Reich, M.; Esztergar, E.P.; Ellison, E.G.; Erdogan, F.; Gray, T.G.F.; Wells, C.W. (Brookhaven National Lab., Upton, N.Y. (USA)). Mar 1977. Contract EY-76-C-02-0016. 93p. Dep. NTIS, PC A05/MF A01.

A survey and review program for application of fracture mechanics methods in elevated temperature design and safety analysis has been initiated in December of 1976. This is the first of a series of reports, the aim of which is to provide a critical review of the theories of fracture and the application of fracture mechanics methods to life prediction, reliability and safety analysis of piping components in nuclear plants undergoing sub-creep and elevated temperature service conditions.

54339 (CONF-770611—13) **Feasibility of denatured LMFBR's.** Burns, T.J.; Bartine, D.E. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; New York, New York, United States of America (USA) (12 Jun 1977).

The use of denatured fuel in nuclear reactors has been proposed as a possible means for alleviating some of the safeguard concerns of the nuclear fuel cycle. In such a fuel, the fissile component would not be chemically separable from the rest of the fuel. Further, such a fuel would be subject to enrichment limitations to prevent direct use as weapons material. This paper summarizes the results of a study directed at investigating the possible use of such a fuel (^{233}U diluted with ^{238}U) in an LMFBR.

54340 (COO—2245-34) **Coolant mixing in LMFBR rod bundles and outlet plenum mixing transients. Progress report, September 1, 1976—November 30, 1976.** Todreas, N.E.; Golay, M.W.; Wolf, L. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). 1976. Contract EY-76-S-02-2245. 215p. Dep. NTIS, PC A10/MF A01.

Information is presented concerning bundle geometry with wrapped and bare rods, subchannel geometry with bare rods, LMFBR outlet plenum flow mixing, and theoretical determination of local temperature fields in LMFBR fuel rod bundles.

54341 (GEFR—00020) **Chemical attack of prospective advanced cladding alloys in simulated mixed oxide fission product environments.** Kangilaski, M.; Adamson, M.G. (Energy, Inc., Idaho Falls, Idaho (USA)). Jan 1977. Contract EY-76-C-03-0893-014. 37p. .

Post-irradiation examination of mixed-oxide fuel rods show a tendency for cesium, molybdenum, tellurium, and iodine fission products to accumulate in the fuel-cladding gap during burnup. Under certain conditions, when the oxygen potential is high, the resulting mixture of fission products in the gap often attacks the inner surface of the stainless steel cladding and produces either a uniform scale of cladding reaction product or an intergranular penetration of the cladding wall to an appreciable depth. To date, these types of attack have been observed in all types of austenitic stainless steel cladding alloys tested in the U.S. LMFBR fuel rod irradiation program. The main concern about chemical attack of the cladding, particularly the intergranular type, is that it increases wastage allowance and limits the lifetime of the fuel rod. If chemical interactions between fuel and a particular cladding compromise its integrity (e.g., by reducing the cladding load bearing area or altering its intrinsic mechanical properties), then the conditions for such interactions must be determined and steps taken to counteract them. A number of alternative alloys to 20% cold-worked Type-316 stainless steel are actively being considered as possible advanced cladding materials. Results are presented for an initial scoping study of the degree of chemical interaction undergone by different alloys in a fuel and fission product environment known to be aggressive towards the present reference cladding alloy (20% cold-worked Type-316 stainless steel).

54342 (ORNL—5158) **Computation system for nuclear reactor core analysis.** Vondy, D.R.; Fowler, T.B.; Cunningham, G.W.; Petrie, L.M. (Oak Ridge National Lab., Tenn. (USA)). Apr 1977. Contract W-7405-ENG-26. 18p. Dep. NTIS, PC A06/MF A01.

This report documents a system which contains computer codes as modules developed to evaluate nuclear reactor core performance. The diffusion theory approximation to neutron transport may be applied with the VENTURE code treating up to three dimensions. The effect of exposure may be determined with the BURNER code, allowing depletion calculations to be made. The features and requirements of the system are discussed and aspects common to the computational modules, but the latter are documented elsewhere. User input data requirements, data file management, control, and the modules which perform general functions are described. Continuing development and implementation effort is enhancing the analysis capability available locally and to other installations from remote terminals.

54343 (ORNL/TM—4573) **Measurement of the transient response of thermocouples and resistance thermometers using an in situ method.** Carroll, R.M.; Shepard, R.L. (Oak Ridge National Lab., Tenn. (USA)). Jun 1977. Contract W-7405-ENG-26. 45p. Dep. NTIS, PC A04/MF A01.

A loop-current step-response (LCSR) method was developed to measure, in situ, the transient response of temperature sensors, such as thermocouples and resistance thermometers. In this method, a sensor is heated with an electric current, and the time dependence of cooling is analyzed when the current is turned off. The cooling analysis is mathematically transformed into an equation to predict the transient response of the sensor to a change of external temperature. The method was verified for a limited class of sensors by comparing the predicted transient response with that measured after plunging the sensors into hot water. The transient responses of sheathed, insulated junction, Chromel/Alumel thermocouples of various diameters were measured with the sensing junction in flowing sodium at temperatures from 180 to 600°C.

54344 (SAND—77-0076) **Nondestructive evaluation of creep-fatigue damage: an interim report.** Nickell, R.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1977. Contract EY-76-C-04-0789. 32p. (NUREG—0178). Dep. NTIS, PC A03/MF A01.

In view of the uncertainties involved in designing against creep-fatigue failure and the consequences of such failures in Class 1 nuclear components that operate at elevated temperature, the possibility of intermittent or even continuous non-destructive examination of these components has been considered. In this interim report some preliminary results on magnetic force and ultrasonic evaluation of creep-fatigue damage in an LMFBR steam generator material are presented. These results indicate that the non-destructive evaluation of pure creep damage will be extremely difficult. A set of biaxial creep-fatigue tests that are designed to discriminate between various failure theories is also described.

54345 (SAND—77-0297C) **Creep buckling analysis of shells.** Stone, C.M.; Nickell, R.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 17p. (CONF-770807—11). Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

The current study was conducted in an effort to determine the degree of conservatism or lack of conservatism in current ASME design rules concerning time-dependent (creep) buckling. In the course of this investigation, certain observations were made concerning the numerical solution of creep buckling problems. It was demonstrated that a nonlinear finite element code could be used to solve the time-dependent buckling problem. A direct method of solution was presented which proved to be computationally efficient and provided answers which agreed very well with available analytical solutions. It was observed that the calculated buckling times could vary widely for small errors in computed displacements. The presence of high creep strain rates contributed to the prediction of early buckling times when calculated during the primary creep stage. The predicted time estimates were found to increase with time until the secondary stage was reached and the estimates approached the critical times predicted without primary creep. It can be concluded, therefore, that for most nuclear piping components, whose primary creep stage is small compared to the secondary stage, the effect of primary creep is negligible and can be omitted from the calculations. In an evaluation of the past and current ASME design rules for time-dependent, load controlled buckling, it was concluded

that current use of design load safety factors is not equivalent to a safety factor of ten on service life for low creep exponents.

54346 (TID—27701/1) **Liquid Metal Fast Breeder Reactor: conceptual plant design, 1000 MWe. Volume I. Executive summary.** (Rockwell International Corp., Canoga Park, Calif. (USA); Burns and Roe, Oradell, N.J. (USA). Breeder Reactor Div.). May 1977. Contract EY-76-C-03-1145;EY-76-C-03-1142. 104p. (FBR—77-3(Vol.1)). .

A synopsis of the conceptual design and performance characteristics of a 1000-MWe Liquid Metal Fast Breeder Reactor (LMFBR) electric-generating power plant is presented. The reactor core utilizes PuO_2-UO_2 fuel and UO_2 breeder elements, in a "bull-seye" configuration, to improve overall breeding, fuel cycle economics, and safety characteristics. The large reactor vessel (49 ft in diameter and 57 ft deep) is resistant to seismic disturbances, and provides a number of inherent safety features. These include: (1) high thermal inertia, (2) accommodation of an in-vessel, diverse, natural-convection Decay Heat Removal System (DHRS), and (3) dual in-vessel reactor inlet pipes for each of the three loops. All three primary loops include an inducer-type mechanical pump with excellent low-NPSH characteristics (maximum 30-ft head requirement). Utilizing the inducer-type pump results in smaller piping and pump sizes. The three intermediate loops each utilize a mechanical pump with a standard centrifugal impeller. The steam generator system employs the "hockey stick" modular units, which operate in a once-through mode. The Decay Heat Removal System consists of three heat rejection paths—the normal, backup, and diverse decay heat removal paths. This diverse-redundant decay heat removal system is an important design feature which provides in-depth assurance of core cooling capability under all conditions, and therefore enhances concept licensability.

54347 (TID—27701/2) **Liquid Metal Fast Breeder Reactor: conceptual plant design, 1000 MWe. Volume II. Plant description.** (Rockwell International Corp., Canoga Park, Calif. (USA); Burns and Roe, Oradell, N.J. (USA). Breeder Reactor Div.). May 1977. Contract EY-76-C-03-1145;EY-76-C-03-1142. 841p. (FBR—77-3(Vol.2)). .

A general plant description for the PLBR conceptual design is presented. The outline includes site characteristics, reactor core, heat transport systems, engineered safety features, instrumentation and control, electric power, auxiliary systems, power conversion systems, buildings and structures, radioactive waste management, radiation protection, and summary safety analyses.

54348 (TID—27701/3) **Liquid Metal Fast Breeder Reactor: conceptual plant design, 1000 MWe. Volume III. Plant/systems trade studies.** (Rockwell International Corp., Canoga Park, Calif. (USA); Burns and Roe, Oradell, N.J. (USA). Breeder Reactor Div.). May 1977. Contract EY-76-C-03-1145;EY-76-C-03-1142. 213p. (FBR—77-3(Vol.3)). .

Trade studies used in the conceptual design of the PLBR are presented. The outline includes trade study methodology, overall plant studies, reactor system studies, reactor support system studies, heat transfer system studies, steam generator system studies, auxiliary system studies, balance of plant studies, and structures and equipment arrangement studies.

54349 (TID—27701/4) **Liquid Metal Fast Breeder Reactor: conceptual plant design, 1000 MWe. Volume IV. R and D requirements.** (Rockwell International Corp., Canoga Park, Calif. (USA); Burns and Roe, Oradell, N.J. (USA). Breeder Reactor Div.). May 1977. Contract EY-76-C-03-1145;EY-76-C-03-1142. 148p. (FBR—77-3(Vol.4)). .

An assessment of the engineering, development, and prototype component testing required to reduce uncertainties and technical risks (unreliability, unavailability) concerning PLBR components to very low levels is presented.

54350 (WARD-RB—3045-18) **Radial blanket flow orificing testing: calibration tests.** Geiger, H.M.; Meess, D.C.; Schmidt, D.K. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Apr 1977. Contract EY-76-C-02-3045-004. vp. .

Flow resistance coefficients were hydraulically determined for a matrix of complex multihole orifice stack geometries which are generic to LMFBR fuel and blanket assemblies. The empirical equations developed from the test data provide the reactor designer with additional guidance for extrapolation of flow resistance coefficients for geometries other that the many geometries tested.

54351 (WARD-SD—3045-4) **Effects of nonuniform geometry and welding on piping elbow design.** Thomas, K. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Apr 1977. Contract EY-76-C-02-3045. 51p. .

Determination of the sensitivity of piping elbows to geometrical and material nonuniformities is necessary for assessment of alternate manufacturing procedures and to aid the selection of fabrication technique. Various processes are used in practice including machining, forming and welding. Machining produces the highest quality product, but is by far the most expensive. In order to achieve an adequate level of structural integrity at minimum cost, it is necessary to determine the material and geometrical nonuniformities characteristic of each fabrication process and to determine by analysis and test their effect on design. This report is an initial step in such an assessment and surveys the known geometric and material nonuniformities associated with piping and elbow manufacture.

54352 **High-voltage electron microscope studies of void swelling.** Buswell, J.T.; Fisher, S.B.; Harbottle, J.E.; Norris, D.I.R. (Central Electricity Generating Board, Berkeley, Eng.). pp 170-179 of In Physical metallurgy of reactor fuel elements. Harris, J.E. (ed.). London; Metal Society (1975).

From International conference on physical metallurgy of reactor fuel elements; Berkeley, England, UK (2 Sep 1973).

See CONF-730912—.

The nucleation and growth of voids has been studied during their formation in a high-voltage electron microscope (HVEM). Specimens of stainless steel, nickel-based superalloys, and pure nickel have been studied. Experiments to investigate the influence of specimen preparation techniques, microscope vacuum, irradiation procedure, thin foil effects, and dislocation density are reported. It is found that hydrogen introduced into alloys during electropolishing can lead to enhanced void nucleation and so drastically influence the swelling behaviour. Experiments in nickel show that a minimum foil thickness is necessary for void growth in the HVEM, otherwise the surfaces dominate and the dislocation density always remains low. The work suggests that the swelling resistance of Nimonic PE16 is associated with a low effective gas content and that hydrogen concentration may be an important factor in both steels and superalloys during reactor irradiation. There is no evidence of a saturation in the swelling of type 316 steel at doses up to 100 dpa.

54353 **Device for sealing and shielding a nuclear fuel storage tank.** Masaki, G. (to Mitsubishi Atomic Power Industries, Inc). Japanese Patent 1976-91,494/A/. 29 Jan 1975. 7p. (In Japanese).

A shield device is described for opening and closing a great opening in a relay-storage-tank within a hot cell for temporarily storing a nuclear fuel. The device is simplified in construction and can perform the opening and closing operation in simple, positive and quick manner. A biological shield is positioned upwardly of an opening of a nuclear fuel storage tank to render an actuator inoperative. A sealing plate, which is pivotally supported by a plurality of support rod devices from the biological shield for parallel movement with respect to the biological shield, comes in contact with a resilient seal disposed along the entire peripheral edge of the opening to form an air-tight seal therebetween. In order to release the opening, the actuator is first actuated and the end of the sealing plate is horizontally pressed by a piston rod thereof. Then, the sealing plate is moved along the line depicted by the end of the support rod in the support rod devices and as a consequence, the piate is moved away from the resilient seal in the peripheral edge of the opening.

54354 **Method of fusing sodium in a freeze zone.** Masuda, S.; Itami, K. (to Hitachi Ltd). Japanese Patent 1976-101,697/A/. 5 Mar 1975. 5p. (In Japanese).

A method is described to permit safe fusion of solidified sodium in the freezing zone in a sodium drain circuit of a sodium cooled fast breeder reactor by varying the quantity of heat added in the axial direction. The quantity of heat added to the freezing zone in the drain duct of a sodium drain circuit of a sodium cooled high speed breeder reactor is varied in the axial direction by arranging the winding pitch of a fusion heater such as an electric heater or induction heating coil such that it is smaller on the side nearer the main cooling loop of the primary cooling system and is greater on the side away from the main cooling loop, thereby permitting effective absorption of the thermal expansion portion for safe fusion when solidified sodium is fused.

54355 **Heating structure for heating machine and pipes in reactor cooling systems.** Seki, K.; Abe, K. (to Hitachi Ltd). Japanese Patent 1976-104,200/A/. 10 Mar 1975. 4p. (In Japanese).

A method is described for heating machine or piping uniformly by the provision of a convection control plate which partially cut off heating air. A fixed band is mounted externally of an electric heater disposed in parallel with the surface of machine or piping so as to be wound about the machine or piping, and a plate portion and a convection control portion are provided thereon to prevent convection of the heating air thereby rendering a temperature difference within the machine or piping uniform.

54356 **Current status of sodium-cooled fast breeder reactor development in Japan.** Mochizuki, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). pp 247-269 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

Two sodium-cooled fast reactors are being developed in Japan, an experimental fast reactor, called "JOYO", now in precommissioning stage and a prototype fast breeder reactor of 300 MWe, called "MONJU" under the check and review by the Government. A variety of R. and D. works are being carried out all through the country, including PNC, JAERI, universities and industries. The O-arai Engineering Center of PNC is the center for undertaking engineering development of the fast breeder reactor. It comprises "JOYO", 50 MW Steam Generator Test Facility, sodium component test facilities, and post-irradiation examination facilities, etc. The current status of both "JOYO" and "MONJU" and R. and D. activities are introduced.

54357 Forecasting operation capability of sodium-cooled fast reactor oxide fuel elements. Golovnin, I.S.; Likhachev, Yu.I. *At. Energ. (USSR);* **40**: No. 1, 27-37(Jan 1976). (In Russian).

34 refs.; 19 figs.; for English translation see the journal Sov. J. At. Energy.

Basic parameters affecting operation capability of sodium-cooled fast reactor oxide fuel elemnts have been determined, principles for selecting their optimal values proposed, and basic phenomena arising in oxide fuel elements during operation considered. Dynamic models of thermally stable and sturdy design of fuel elements and criteria for estimating operational reliability based on theoretical considerations and experimental data on the behavior of materials in and outside of reactors have been selected.

54358 Development of fast breeder reactor in Japan. Suzuki, Y. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Genshiryoku Kogyo;* **22**: No. 6, 30-34(Jun 1976). (In Japanese).

In Japan, which lacks of energy resources, the development of fast breeder reactors is absolutely necessary, and it is promoted powerfully as a national project since 1967. The experimental reactor Joyo of 100 MW thermal output was completed, and the functional test is carried out now. The prototype reactor Monju is the power-generating reactor of 300 MW(e), and its coordinating design is in progress now. In case of Monju, sufficient consideration was given especially to the seismatic design. The researches on reactor physics, structural equipment, measurement and control, sodium technology, fuel materials, safety and steam generators are carried out to support the project.

54359 Thermal properties of simulated fuel pin for FBR. Takahashi, Y. (Sukekawa Electric Co. Ltd., Tokyo (Japan)). *Genshiryoku Kogyo;* **22**: No. 8, 43-48(Aug 1976). (In Japanese).

The development of simulated fuel pins for an FBR is reviewed from the viewpoint of the thermal properties of the heater element and thermal insulator. The fundamental structure of the simulated fuel pin and the basic equations for heat transfer are presented in the first part. An equation for the ratio of the local electric resistance at the top end of the heater to the average resistance is derived in the second part. An equation for the thermal load distribution is given in the third part together with the experimental results on the axial distributions of electrical resistance and thermal load and the temperature distributions of the heater element, sheath and sodium coolant. The maximum heat flux was 283 W/cm^2. As for the thermal insulator, the thermal conductivity and the electric resistance of some insulators are given as functions of temperature. The thermal stress of the heater element is analyzed in the fourth part. In the fifth part, some analysis is made on the realization of a heater with cosine heat flux distribution.

54360 C-scope under-sodium viewer for sodium-cooled fast breeder reactor. Miyazawa, T.; Uesugi, N.; Iguchi, T.; Taguchi, J.; Takagi, N. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan). Research and Development Center). *Toshiba Rebyu;* **31**: No. 9, 783-787(Sep 1976). (In Japanese).

A C-scope under-sodium viewer has been developed for monitoring the interior of sodium-cooled fast breeder reactors. Consisting of a transducer that emits and receives ultrasonic waves under liquid sodium, a mechanism that drives the transducer under liquid sodium and an image displaying section, it inspects the fuel assembly through its image in optically opaque high-temperature (300°C) liquid sodium. The results of its evaluation test are: (1) the transducer could continue satisfactory operation under 350°C (at the highest) sodium for more than a month; (2) the driving mechanism, though it was the first of the kind appearing in Japan, has been proved that it could continue operation for a week under 300°C sodium; (3) the image displaying section, in spite of the low speed of the transducer (below 20 rpm), could display stable and clear images; and (4) the image in 300°C was as clear as that in room-temperature water.

54361 Continuous method of determining the thermodynamic activity of carbon in sodium. Asher, R.C.; Kirstein, T.B.A. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 561-566 of In Liquid metals, 1976. Evans, R.; Greenwood, D.A. (eds.). Bristol; Institute of Physics (1977).

From 3. international conference on liquid metals; Bristol, UK (12 - 16 Jul 1976).

The Harwell carbon meter (HCM) provides a continuous indication of the thermodynamic carbon activity in liquid sodium. This information is important with respect to the carburization and decarburization of steel components of sodium-cooled fast reactors. A description of the HCM is given. It has been shown to respond rapidly to changes in carbon activity, to give an output which is in satisfactory agreement with spot calibrations using nickel 'tabs' and to operate reliably without failure for long periods.

54362 Manufacture and properties of ceramic probes to measure oxygen content in liquid sodium. Wheatley, C.C.H.; Leach, F.; Hudson, B.; Thompson, R.; Claxton, K.J.; Asher, R.C. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp 556-560 of In Liquid metals, 1976. Evans, R.; Greenwood, D.A. (eds.). Bristol; Institute of Physics (1977).

From 3. international conference on liquid metals; Bristol, UK (12 - 16 Jul 1976).

In sodium-cooled fast reactors (and elsewhere) it is important to be able to measure continuously the oxygen levels in the sodium circuits. For example, a sudden increase in the oxygen level in a secondary coolant circuit of a reactor might indicate a water leak from the heat exchanger. Some aspects of the development of an electrochemical oxygen meter for use in sodium are desribed. A ceramic probe in the form of a closed-ended tube of thoria -7 1/2% yttria is immersed in the sodium and the EMF generated between the sodium and an internal standard reference electrode can be used to monitor the oxygen level in the sodium. The electrolyte tubes are manufactured by a procedure which gives a dense ceramic of high chemical purity and hence freedom from spurious EMFs caused by impurities. The properties of the probes and experience obtained with them in sodium are described.

54363 Simplified model of inert gas bubble dynamics in liquid metals. Singer, R.M.; France, D.M.; Minkowycz, W.J. (Argonne National Lab., IL). *Int. J. Heat Mass Transfer;* **20**: No. 1, 87-88(Jan 1977).

An analytical model of the dynamic behavior of an inert gas bubble flowing with a dilute solution of the gas in a liquid metal was developed. Included in the model were many processes normally neglected under steady-state or quasi-steady conditions but which may become important during rapid transients. The completeness of the mathematical model required for the accurate analysis of bubble dynamics is strongly dependent upon the severity of the thermal-hydraulic transient to which the bubble is subjected. In the model developed many terms were retained that represent physical phenomena which can be shown to be negligible under steady-state, quasisteady state and mild transient conditions. These terms would normally be eliminated from the mathematical model at the outset for application to such cases. However, extensive numerical calculations were performed using this complete model for cases that include both severe and mild thermal/hydraulic transients.

54364 UK experiments on fast-reactor containment. *Elektro-Anz.;* 41(Apr 1977).

In a liquid-metal-cooled fast reactor construction the core is normally housed in a concrete vault providing full containment and it is necessary to penetrate the roof of the vault to gain access to the core for refuelling purposes. A method is discussed where the vault roof has only a small aperture for refuelling purposes.

54365 Design and testing of a self-actuated shut down system for the protection of liquid metal fast breeder reactors (LMFBRs). Josephson, J.; Sowa, E.S. (Argonne National Lab., IL). *IEEE Trans. Nucl. Sci.;* **NS-24**: No. 2, 919-930(Apr 1977).

The design and testing of a simple and reliable Self-Actuated Shutdown System (SASS) for the protection of Liquid Metal Fast Breeder Reactors (LMFBRs) is described. A ferromagnetic Curie temperature permanent magnet holding device has been selected for the design of the Self-Actuated Shutdown System in order to enhance the safety of liquid metal cooled fast reactors (LMFBRs). The self-actuated, self-contained device operates such that accident conditions, resulting in increased coolant temperature or neutron flux reduce the magnetic holding force suspending a neutron absorber above the core by raising the temperature of the trigger mechanism above the Curie point. Neutron absorber material is then inserted into the core, under gravity, terminating the accident. Two possible design variations of the selected concept are presented.

54366 Natural convection in a volumetrically heated fluid layer at high Rayleigh numbers. Cheung, F.B. (Argonne National Lab., IL). *Int. J. Heat Mass Transfer;* **20**: No. 5, 499-506(May 1977).

A phenomenological model of eddy heat transport in natural convection with volumetric energy sources at high Rayleigh numbers is developed. The model is applied to the problem of thermal convection in a horizontal heated fluid layer with an adiabatic lower

boundary and an isothermal upper wall. A correlation for mean Nusselt numbers is obtained for steady heat transfer. Distributions of the mean turbulent temperature, the eddy heat flux, and production of thermal variance in the heated fluid are presented. The mechanism of turbulent convection at high Rayleigh numbers is discussed. Comparison is made with existing experiments and found to be good.

54367 LMFBR commercial plant design. Roecker, J.H. (Atomics International). *Trans. Am. Nucl. Soc.;* **26**: 432(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54368 Water/sodium temperature-fluctuation correlation mixing-tee experiments. Kasza, K.E.; Oras, J.J. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 432-433(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54369 Multiple-jet thermal mixing in a piping tee. Lykoudis, P.S.; Hagar, R.C. (Purdue Univ., West Lafayette, IN). *Trans. Am. Nucl. Soc.;* **26**: 433-434(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54370 Design and development of the CRBRP ex-vessel transfer machine. Jones, C.E. Jr. (Atomics International, Canoga Park, CA). *Trans. Am. Nucl. Soc.;* **26**: 436-437(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54371 Optimized method for orificing LMFBR cores. Carelli, M.D.; Friedland, A.J.; Bach, C.W.; Markley, R.A. (Westinghouse Advanced Reactors Div., Madison, PA). *Trans. Am. Nucl. Soc.;* **26**: 437-438(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54372 Analysis of a high-sensitivity fission counter for operation in high gamma fields. Valentine, K.H.; Burns, R.S.; De Lorenzo, J.T.; Clay, W.T. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 440-441(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54373 Development and testing of an LMFBR fuel pin plenum pressure transducer. English, J.J. (Argonne National Lab., IL); Spencer, B.W.; Pedersen, D.R.; Witte, A. *Trans. Am. Nucl. Soc.;* **26**: 441-442(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54374 Core design methods for advanced LMFBRs. Chandler, J.C.; Marr, D.R.; McCurry, D.C.; Cantley, D.A. (Westinghouse Hanford Co., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 447-448(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54375 Simplified reactor physics model for core design optimization. Lu, Y.S.; Bailey, H.S. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.;* **26**: 448-449(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54376 Application of nonlinear network analysis to hydraulic modeling of LMFBR vented assembly cores. Dubberley, A.E.; Jac. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.;* **26**: 449-450(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54377 Bouyancy-induced flow redistribution in reactor vessel of an LMFBR. Yang, J.W.; Agrawal, A.K. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 450(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54378 Thermal performance prediction of multiplate insulation for LMFBR systems. Jones, B.G.; Shiu, K.K. (Univ. of Illinois, Urbana). *Trans. Am. Nucl. Soc.;* **26**: 450-452(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54379 Flow orificing of large LMFBR cores with interassembly heat transfer. Khan, E.U.; Barthold, W.P. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 452-454(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54380 Flow split measurements in an LMFBR radial blanket assembly. Chiu, C.; Todreas, N.E. (Massachusetts Inst. of Tech., Cambridge). *Trans. Am. Nucl. Soc.;* **26**: 455-456(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54381 Sensitivity of sodium void reactivity to changes in basic design conditions of oxide LMFBRs. Turski, R.B.; King, M.J.; Orechwa, Y. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 457-458(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54382 Sodium void and doppler reactivities in oxide and carbide LMFBRs. Su, S.F.; Barthold, W.P. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 458-459(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54383 Pin-diameter optimization in 1200-MW(e) heterogeneous vs homogeneous LMFBRs. Orechwa, Y.; Turski, R.B.; King, M.J. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 459-460(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54384 Deflection of wire-spaced fuel pin bundles. Sakai, K.; Okubo, Y.; Hishida, H. (Mitsubishi Atomic Power Industry, Inc., Saitama, Japan). *Trans. Am. Nucl. Soc.;* **26**: 460-461(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54385 Neutron and gamma transport effects in heterogeneous core designs. Lam, S.K. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 462-463(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54386 Effective conduction mixing lengths for subchannel analysis of finite hexagonal LMFBR bundles. Yeung, M.; Wolf, L. (Massachusetts Inst. of Tech., Cambridge). *Trans. Am. Nucl. Soc.;* **26**: 463-464(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54387 General status of accuracy of ENDF/B-IV cross sections for LMFBR shielding calculations. Maerker, R.E. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 485-486(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54388 Monte Carlo analyses of intermediate sodium activation in an LMFBR. Cardito, J.M.; Boulette, E.T. (Stone and Webster Engineering Corp., Boston). *Trans. Am. Nucl. Soc.;* **26**: 494(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54389 Observation of a 12-Hz effect in the upper plenum of EBR-II. Carey, W.M.; Popper, G.F.; Curran, R. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 521(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54390 MIXTAG: a code to identify the components of a mixture of xenon tags. So, B.Y.C.; Stauffer, G.W. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 522-523(Jun 1977).

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54391 GCFR lattices with Kα close to unity: comparison of measured and calculated integral data. Seth, S.; Brunson, G.; Gmuer, K.; Richmond, R. (Swiss Federal Inst. for Reactor Research, Wuerenlingen). *Trans. Am. Nucl. Soc.;* **26**: 533-534(Jun 1977).

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54392 Assessment of the structural material Doppler effect for fast reactors. Heindler, M. (Inst. for Theoretical Physics and Reactor Physics, Graz); Harms, A.A. *Trans. Am. Nucl. Soc.;* **26**: 540(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54393 Considerations pertinent to rigorous and efficient structural doppler effect calculations. Toppel, B.J.; Hwang, R.N. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 540-542(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54394 Performance parameter uncertainties for a large LMFBR. Marable, J.H.; Weisbin, C.R. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 542-543(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54395 Sensitivity of reactivity effects to the choice of reactor models. Woodruff, W.L. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 543-544(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54396 Sensitivity of the power distribution in large heterogeneous LMFBR designs. Tzanos, C.P.; Barthold, W.P. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 544-545(Jun 1977).

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54397 Systematic approach for constructing low sodium void heterogeneous cores. Tzanos, C.P.; Barthold, W.P. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 548-549(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54398 Potential and limitation of the heterogeneous reactor concept. Barthold, W.P.; Beitel, J.; Khan, E.; Tzanos, C. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 552-553(Jun 1977).

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54399 Preliminary physics studies of a large fast core based on the heterogeneous concept. Sicard, B.; Mougniot, J.C.; Sztark, H.; Cabrillat, J.C.; Giacometti, C.; Carnoy, M.; Clauzon, P. (CEA, Cadarache, France). *Trans. Am. Nucl. Soc.;* **26**: 553(Jun 1977).

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54400 Nuclear design and economic comparison of a conventional and bullseye LMFBR core. Vitti, J.A.; Felten, L.D.; Galluzzo, N.G.; Otter, J.M. (Atomics International, Canoga Park, CA). *Trans. Am. Nucl. Soc.;* **26**: 553-554(Jun 1977).

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54401 Physics performances of heterogeneous fast reactor core concept studied in MASURCA. Bouget, Y.H. (CEA, Cadarache, France); Desprets, A.; Hammer, P.; Humbert, G.; Lyon, F.; Wiesenfeld, B.; Martini, M.; Cosimi, M.; Broccoli, U. *Trans. Am. Nucl. Soc.;* **26**: 554-555(Jun 1977).

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54402 ZPPR critical experiments for a radial parfait reactor. Lineberry, M.J. (Argonne National Lab., Idaho Falls, ID); Carpenter, S.G.; McFarlane, H.F.; Collins, P.J.; Amundson, P.I.; Stewart, S.L.; Hitchcock, J.T. *Trans. Am. Nucl. Soc.;* **26**: 555-556(Jun 1977).

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54403 Nuclear performance of LMFBRs designed to preclude energetic HCDAs. Bailey, H.S.; Lu, Y.S. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.;* **26**: 557-558(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54404 Studies of the heterogeneous LMFBR core concept for several fuel cycles and its sensitivity to design and cross-section changes. Bruna, G.B. (NIRA, Genova); Cecchini, G.P.; Gastaldo, G.; Kallfelz, J.M.; Palmiotti, G.; Salvatores, M.; Rowland, D.; Bartine, D.; Burns, T. *Trans. Am. Nucl. Soc.;* **26**: 558-559(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54405 LMFBR core design with favorable safety parameters. Sehgal, B.R.; Lin, C.; Fuller, E.L.; Loewenstein, W.B. (Electric Power Research Inst., Palo Alto, CA). *Trans. Am. Nucl. Soc.;* **26**: 559-561(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54406 Physics studies of a heterogeneous core concept for SNR-2. Spenke, H. (Interatom, Gladbach, Ger.); Wehmann, U.; Pilate, S.; de Wouters, R.; Kiefhaber, E. *Trans. Am. Nucl. Soc.;* **26**: 561(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54407 LMFBR heterogeneous core designs with axial internal blankets. Naser, J.A.; Sehgal, B.R.; Winkleblack, K. (Electric Power Research Inst., Palo Alto, CA). *Trans. Am. Nucl. Soc.;* **26**: 561-562(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54408 Integral capture cross sections of steel, iron, and ^{239}Pu in GCFR lattices. Seth, S.; Richmond, R. (Swiss Federal Inst. for Reactor Research, Wuerenlingen). *Trans. Am. Nucl. Soc.;* **26**: 570-571(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54409 Multigroup time-dependent delayed gamma spectra from fission and activation of uranium and plutonium. Hermann, O.W.; Bjerke, M.A.; Weisbin, C.R. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 570-572(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54410 Fissile fuel breeding with the spallation breeder. Harms, A.A.; Gordon, C.W. (McMaster Univ., Hamilton, Ontario). *Trans. Am. Nucl. Soc.;* **26**: 582-583(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54411 Definitions of breeding ratio and doubling time. Greebler, P. (General Electric Co., San Jose, CA); Wyckoff, H.L. *Trans. Am. Nucl. Soc.;* **26**: 584(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54412 Significance of breeding ratio and doubling time definitions to LMFBR technology programs. Hemmig, P.B.; Lewellen, J.W.; Lowery, V.W. (Energy Research and Development Administration, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 585(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54413 Breeding ratio and doubling time definitions for the CRBRP Project. Wilson, C.L.; Gibbs, D.C. (CRBRP Project Office, Oak Ridge, TN). *Trans. Am. Nucl. Soc.;* **26**: 585-586(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54414 **Theoretical comparison of various fuel growth rate descriptions.** Ott, K.O.; Borg, R.C.; Maudlin, P.J. (Purdue Univ., West Lafayette, IN). *Trans. Am. Nucl. Soc.;* **26**: 586-587(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54415 **Expression for the compound system doubling time which explicitly includes the approach to equilibrium.** Marr, D.R.; Hardie, R.W.; Omberg, R.P. (Westinghouse Hanford Co., Richland, WA). *Trans. Am. Nucl. Soc.;* **26**: 587-588(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54416 **Breeding ratio and doubling time definitions used for advanced fuels performance characterization.** Barthold, W.P.; Chang, Y.I. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 588-590(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54417 **Educational aspects of breeding parameters.** Murray, R.L.; Ingram, J.C. (North Carolina State Univ., Raleigh). *Trans. Am. Nucl. Soc.;* **26**: 590(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54418 **New insulations for breeders being tested.** *Electr. World;* **187**: No. 12, 37-39(15 Jun 1977).

Testing of insulation techniques for high-temperature liquid-sodium lines of breeder reactors, necessary before commercialization, is underway at the ERDA-funded Fast Flux Test Facility (FFTF) near Richland, Wash. Insulation materials must (1) not react chemically with sodium, (2) resist 1,050°F temperatures (twice the requirement for pressurized water reactors), (3) be able to withstand a lifetime exposure to high radiation levels, (4) be compact and easily removed for servicing, (5) accomodate electric heaters to keep the sodium liquid, and (6) be able to perform special functions of chilling sodium and heating inert gases. Exhaustive tests identified three Johns-Manville materials for testing at the facility: Thermo-12 calcium silicate for temperatures below 800°F, Cerablanket for higher temperatures, and Min-K for tight areas requiring flexibility. Pipe insulation in the FFTF is necessary to keep structural concrete and electrical wiring from deteriorating. The tests will also check heat retention for protection against Btu loss in future power reactors. (DCK)

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 54596, 54636

54419 (CONF-760822—P2, pp 1089-1103) **Use of ANSI N-509 in design and licensing of nuclear air cleaning systems.** Thompson, C.A. (Bechtel Power Corp., Gaithersburg, MD). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

American National Standard N-509, "Nuclear Power Plant Air Cleaning Units and Components", has been prepared for ASME by an ad hoc committee (N45-8.1) of the Subcommittee on Nuclear Power Plant Air and Gas Cleaning Systems (N45-8). After reviewing the background of N-509, the standard is described and its use in design and licensing of nuclear air cleaning systems is discussed.

54420 (CONF-760822—P2, pp 1104-1112) **Recent developments in NRC guidelines for atmosphere cleanup systems.** Bellamy, R.R. (U.S. Nuclear Regulatory Commission, Washington, DC). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The Nuclear Regulatory Commission (NRC) maintains the policy of updating when necessary, its published guidance for the design of engineered safety feature (ESF) and normal ventilation systems. The guidance is disseminated by means of issuing new, or revisions to, existing Regulatory Guides, Standard Review Plans, Branch Technical Positions and Technical Specifications. A revised Regulatory Guide, new Technical Specifications and new Standard Review Plans with Branch Technical Positions for atmosphere cleanup systems are discussed. Regulatory Guide 1.52, "Design, Testing and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants," was issued in July 1973. The major comments received from the nuclear industry since the guide was issued, NRC's experience in implementing the guide in recent license applications, status of operating plants in meeting the guidelines and NRC's continuing assessment of operating data and laboratory tests to assure that the guide reflects the latest technology are discussed.

54421 (CONF-760822—P2, pp 1113-1122) **Impact of Appendix I to 10 CFR Part 50 on atmosphere cleanup systems.** Collins, J.T. (U.S. Nuclear Regulatory Commission, Washington, DC). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Dose design objectives in Appendix I to 10 CFR Part 50 for gaseous effluents from light-water-cooled nuclear power plants, the need for a cost-benefit analysis for certain proposed facilities, one acceptable method for performing a cost-benefit analysis, and the cost of ventilation equipment considered by the staff in its evaluation are discussed. The cost-benefit analysis will be used to show when additional radwaste equipment will be required.

54422 (DOCKET-50250—694) **Turkey Point Plant, Units 3 and 4. Annual operating report for 1976.** (Florida Power and Light Co., Miami (USA)). 1 Mar 1977. vp. (DOCKET-50251—683). Dep. NTIS, PC A04/MF A01.

Both units were essentially base leaded at rated power. Unit 4 was removed from service for its second refueling on April 10, and returned to service June 6. Unit 3 was removed from service on November 14 for its third refueling and returned to service January 16, 1977. Information is presented concerning operations, maintenance, power reductions, radiation exposures, failed fuel, eddy current tests, ultrasonic tests, and visual examinations. (FS)

54423 (DOCKET-50266—599) **Point Beach Nuclear Plant, Units 1 and 2. Annual operating report: January—December 1976.** (Wisconsin Electric Power Co., Milwaukee (USA)). [nd]. vp. (DOCKET-50301—579). .

Unit 1 generated 227,877 MWH with the generator on-line 540 hrs and Unit 2 generated 324,954 MWH with the generator on-line 696 hrs. Information is presented concerning operating experience; procedure changes, tests, and experiments; maintenance, licensee event reports and other events of interest; data tabulations of electric power generation, unit shutdowns, forced power reductions, and number of personnel and Man/Rem exposure; eddy current testing of steam generator tubes; and fuel history. (FS)

54424 **Floating nuclear power plant: environmental and safety licensing considerations.** Haupt, C.A. (Nuclear Regulatory Commission, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 422-423(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54425 (NP—22292) **Cleaning up the remains of nuclear facilities: a multibillion dollar problem. (EMD—77-46).** (General Accounting Office, Washington, D.C. (USA)). 16 Jun 1977. 41p. Accounting Office, Washington, DC.

Report to the Congress by the Comptroller General of the United States.

NRC and ERDA programs for disposing of nuclear facilities after their shutdown are reviewed. The costs involved are discussed and some recommendations are presented.

54426 **Kernenergiewet. (Nuclear Energy Law).** de Boer, J.W.A. (Ministerie van Volksgezondheid en Milieuhygiene, Leidschendam (Netherlands)). Zwolle; W.E.J.Tjeenk Willink (1976). 450p. (In Dutch).

The texts of nuclear laws in force in the Netherlands are reproduced in extenso together with the corresponding Exposes des Motifs. The major law is the Nuclear Energy Act of 21 February 1963 as amended successively in 1967 and 1974. The purpose of this Act is to promote nuclear energy development, to regulate the use of radioactive substances and equipment emitting ionizing radiation and to provide protection against the hazards involved in the use of nuclear energy. To this effect, a series of Decrees and Directives were enacted, implementing various sections of the Act and also defining it further, one of the most important being the Nuclear Installations, Fissionable Materials and Ores Decree of 4 September 1969. In preparation of the ratification of the Paris Convention and Brussels Supplementary Convention on nuclear third party liability, the Netherlands published an Act on Third Party Liability in the Field of Nuclear Energy on 27 October 1965 which was amended by an Act of 8 October 1969. Also, with a view to ratifying the 1962 Brussels Convention on the liability of nuclear ship operators, an Act on the Liability of Operators of Nuclear Ships was published on 24 October 1973. Finally, a series of Euratom Regulations concerning several Articles of the Euratom Treaty, as well as the Euratom Basic Radiation Protection Standards of 2 February 1959, as amended in 1962 and 1966, are reproduced in full (NEA).

54427 Modification in reactor facilities of Oi Nuclear Power Station, Kansai Electric Power Co., Inc. *Genshiryoku Iinkai Geppo;* **21**: No. 6, 3-8(Aug 1976). (In Japanese).

This is the report submitted by the chairman of Atomic Energy Commission of Japan to the prime minister, dated June 1, 1976, in which the application of permission on the subject is approved to be in conformity with the related criteria. The modifications investigated are as follows: (1) change of the site area, (2) revision of the fuel assembly from 15 x 15 to 17 x 17 type, (3) upgrading the storage capacity of spent fuel storing facility from the capacity corresponding to approximately 5/3 core to 11/3 core, (4) adding the upper injection system of the reactor core to the existing emergency core cooling system, (5) adding high neutron flux changing rate (power range) to the actuating signals for reactor shut-down circuit, (6) changing the control rod composition from 20 rods/cluster of boron-carbide to 24 rods/cluster or silver, indium and cadmium alloy, (7) increasing three waste resin-storing tanks, and (8) installing the equipment for controlling inflammable gas concentration in the containment vessel to suppress the concentration of hydrogen. In addition, since the distance from the reactor to the boundary of peripheral monitoring area was shortened, exposure dose assessment was performed and the result far below the objective value was obtained. Some analyses were carried out to confirm the safety.

54428 Modification in reactor facilities of Tsuruga Nuclear Power Station, Japan Atomic Power Co., Ltd. *Genshiryoku Iinkai Geppo;* **21**: No. 6, 8-9(Aug 1976). (In Japanese).

This is the report submitted by the chairman of Atomic Energy Commission of Japan to the prime minister, dated June 1, 1976, in which the application of permission on the subject is approved to be in conformity with the criteria for permission in the related laws. The modification to be investigated is the new installation of a steam generator for turbine shaft sealing in which the steam produced by heating condensate tank water with the generator is used as low pressure, turbine shaft sealing steam (before the modification, the steam generated in the reactor is used). Its purpose is the reduction of radioactive substances in exhausted gas in normal operation, and the reactor safety is not impaired by the modification. Evaluation of exposure dose was performed in the circumference of the reactor facilities, due to the radioactive substance released in normal operating condition. The result showed that the released rate of rare gases and iodine was reduced to approximately 1/3.5 of the value so far. From this result, the maximum gamma exposure dose of a human whole body due to radioactive rare gases is estimated as 1.8 mrem a year in possible inhabitable locations, and the maximum thyroid gland exposure dose due to radioactive iodine is 1.6 mrem (infant). These are well below the objective values specified in the guide for the target values of dose in the facilities of light water reactors for power generation.

54429 Norway gets more influence in siting of nuclear power reactors. *Planet. Space Sci.;* **25**: No. 3, 46(31 Mar 1977). (In Norwegian).

In a brief notice it is stated that the authorities in the Nordic countries (Denmark, Finland, Norway and Sweden) shall inform each other about nuclear power plants and other nuclear facilities planned near national borders, and give due consideration to the views of the other countries. This is a result of a Danish initiative following criticism of the siting of the Barsebaeck nuclear power plants on the Swedish coast opposite Copenhagen. The agreement does not give any fixed distance from the border at which a nuclear plant may be sited, nor to what extent a neighbouring country's views must be acceded to.

54430 EPA standards. *Radiol. Prot. Bull.;* No. 19, 3(Apr 1977).

The US EPA environmental radiation protection standards for normal operations of activities in the uranium fuel cycle, entered on the US Federal Register on January 13, 1977 (Subchapter F and Part 190 added to Title 40, Code of Federal Regulations, Chapter 1) are of great importance in radiological protection, but certain numerical values have already been quoted out of context. Their limits of application are emphasized. The standards were based on cost effectiveness studies and were specifically for light water reactor uranium fuel cycles. The conclusions cannot therefore be related directly to other forms of nuclear fuel cycle. The EPA standards only replace the Dose Limits for members of the public in the current recommendations of ICRP and the US Federal Radiation Protection Guides in regard to the light water reactor fuel system.

54431 Environmental radiation protection standards for normal operations of activities in the uranium fuel cycle. *Radiol. Prot. Bull.;* No. 19, 3-5(Apr 1977).

Entries on the US Federal Register on January 13, 1977 (additions to Title 40, Code of Federal Regulations, Chapter 1) are reproduced in full. The entries consist of a new Subchapter F (Radiation Protection Programs) and Part 190 (Environmental Radiation Protection Standards for Nuclear Power Operations). The terms used are defined. The legislation is applicable to radiation doses received by members of the public in the general environment and to radioactive materials introduced into the environment as a result of operations which are part of a nuclear fuel cycle. The Environmental Standards for the uranium fuel cycle are established, and the conditions under which these standards may be exceeded defined. The effective dates for compliance with the different limitations range from December 1, 1979 to January 1, 1983.

54432 Legal problems in the licensing of floating nuclear power plants. Conner, T.B. Jr. *Trans. Am. Nucl. Soc.;* **26**: 423-424(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54433 Geological considerations in reactor licensing. Scott, J. *Trans. Am. Nucl. Soc.;* **26**: 431(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54434 Current trends in licensing. Allison, D. (Nuclear Regulatory Commission, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 431(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54435 Engineer/constructor approach to standardization in licensing. Keith, D. (Bechtel Power Corp., San Francisco). *Trans. Am. Nucl. Soc.;* **26**: 431(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54436 Licensing: new requirements and projected impact. Bland, M. (NUS Corp., Rockville, MD). *Trans. Am. Nucl. Soc.;* **26**: 431(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54437 Efficiencies in the coordination and integration of the state and federal processes. Goliamp, L. *Trans. Am. Nucl. Soc.;* **26**: 431(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54438 Changing regulatory scene. Gehr, A. *Trans. Am. Nucl. Soc.;* **26**: 431(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54439 Decommissioning of the SRE. Heine, W.F.; Graves, A.W.; Ureda, B.F. (Atomics International, Canoga Park, CA). *Trans. Am. Nucl. Soc.;* **26**: 435-436(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

ECONOMICS

54440 Increased nuclear capacity vital. Whillier, J. *S. Afr. J. Anim. Sci.;* 4-5,7(Sep 1976).

The rapid depletion of the world's fossil fuel resources and increased industrialisation has forced man to search for alternative sources of heat for power generation. The most efficient system is that of making use of controlled nuclear fission. This article reflects the current state of nuclear power generation technology and availability of uranium as the prime fuel.

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 53630, 54083

54441 High temperature materials requirements in reforming of gaseous hydrocarbons with HTR heat. Niessen, H.F.; Kugeler, K.; Kugeler, M. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). *Rev. Int. Hautes Temp. Refract.;* **13**: No. 4, 204-211(1976).

From 1. Petten colloquium on advanced high temperature material: technological and industrial aspects; Petten, Netherlands (29 - 30 Jan 1976).

In FRG a new project has been started a few month ago. The aim of this project is the development, design and construction of a

nuclear process heat prototype plant for coal gasification. In this paper the helium-heated steam reformer is discussed as a typical example for a process heat exchanger. Not only the requirements for helium-heated reformer tube materials are shown but also a comparison to the conventional techniques is given (temperatures, heat transfer, heat fluxes, stresses in the steam reformer tubes, hydrogen and tritium permeation, corrosion of tube materials).

NUCLEAR REACTOR TECHNOLOGY

54442 Genken 20nenshi. (Twenty years history of Japan Atomic Energy Research Institute). Tokyo, Japan; Japan Atomic Energy Research Institute (1976). 339p. (In Japanese).

Following the 10 years history issued previously, activities of JAERI in the past 20 years are described chronologically, with emphasis on the past 10 years. Issuance of the present history corresponds with the 20th anniversary of JAERI's foundation. The personnel now number a total of 2,262 and the yearly budgets amount to 33,410 million Yen. Publications by JAERI personnel in the past 20 years are about 14,238. Featured by conceptual design of an experimental fast reactor development of a multi-purpose high-temperature gas cooled reactor, etc., activities of the JAERI now are in three major pillars of nuclear energy generation system, nuclear safety, and radiation utilization.

54443 NEED in Chicago with Commonwealth Edison and the National Technical Association. Reed, C. (Commonwealth Edison Co., Chicago). *Trans. Am. Nucl. Soc.;* **26**: 607(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54444 National Society of American Indian Engineers: origin and future. Thomas, G. (Univ. of Oklahoma, Norman). *Trans. Am. Nucl. Soc.;* **26**: 607-608(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54445 Nuclear Technology Workshop, a NEED Project at Oregon State University. Peddicord, K.L. (Oregon State Univ., Seattle). *Trans. Am. Nucl. Soc.;* **26**: 608-609(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54446 NEED's need now. Miller, W.F. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 609(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 55334

54447 (AD-A—038775) Finite element solution of a three-dimensional nonlinear reactor dynamics problem with feedback. Bermudez, E.C. (Naval Postgraduate School, Monterey, Calif. (USA)). Dec 1976. 160p. NTIS PCA08/MF A01.

Thesis.

This work examines the three-dimensional dynamic response of a nonlinear fast reactor with temperature-dependent feedback and delayed neutrons when subjected to uniform and local disturbances. The finite element method was employed to reduce the partial differential reactor equation to a system of ordinary differential equations which can be numerically integrated. A program for the numerical solution of large sparse systems of stiff differential equations developed by Franke and based on Gear's method solved the reduced neutron dynamics equation. Although a study of convergence by refining element mesh sizes was not carried out, the crude finite element mesh utilized yielded the correct trend of neutron dynamic behavior.

54448 (CONF-770611—1) National laboratory—university cooperative development of power plant noise surveillance methods. Fry, D.N. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; New York, New York, United States of America (USA) (12 Jun 1977).

Some of the benefits of cooperative research and development of surveillance and diagnostic methods by universities and ORNL are discussed.

54449 (KFKI—76-31) Transient response of a coolant channel to power variations, the computer program RHDK. Egeli, G.; Toth, I.; Toeroek, A. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). Jun 1976. 32p. Dep. NTIS (US Sales Only), PC A03/MF A01.

2 figs.; 6 tabs.; Appendix.

The paper starts with a brief survey of the literature of the two-region problem of a single heater cooled from the outside by a fluid. After that the transfer functions of the temperatures are derived analytically by help of Laplace transformation. It is shown that the results have the same form for heaters of tube, rod and slab geometry. To evaluate the system response to a step change in heating power by help of inverse Laplace transformation the computer program RHDK has been written. The last part of the paper contains the description of this code.

54450 (LA—6800-PR) Transport and reactor theory. Progress report, January 1—March 31, 1977. Miller, W.F. Jr.; Dudziak, D.J.; O'Dell, R.D.; Gomez, M.F. (comps.). (Los Alamos Scientific Lab., N.Mex. (USA)). May 1977. Contract W-7405-ENG-36. 37p. Dep. NTIS, PC A03/MF A01.

The Fusion Reactor Nucleonics Section continued development of a two-dimensional, triangular spatial mesh transport code for fusion reactor analysis in r-z and x-y geometries. Additionally, a complete redesign of the Reference Theta-Pinch Reactor blanket is reported under our System Study effort. Finally, shielding analyses and design calculations for the Intense Neutron Source, the High Energy Gas Laser Facility and a Space Electric Power Supply fast-fission reactor are reported. The Supporting Research and Development Section reports on new developments in synthetic and rebalance iteration acceleration schemes. Alterations are reported to the one-dimensional neutron transport code ONETRAN making it more useful to LASL users. New developments in angular quadrature sets and modeling hydrogen transport in toroidal plasmas are also presented. The LMFBR Physics Section in Group T-1 reports on activities in developing a three-dimensional discrete-ordinates capability. Research in synthetic diffusion acceleration in two dimensions is presented. Code developments of a software nature are also discussed. New work in application of the SIMMER code to loss-of-flow accidents in the CRBR is described.

54451 Standard neutron field. 2-1. Kanda, K. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). pp 41-48 of In Present status and problems of reactor neutron study. Tokyo, Japan; Atomic Energy Society of Japan (1976). (In Japanese)

When the experiment and the theory are compared concerning neutron groups, simple comparison of interaction is meaningless without the establishment of neutron field as sufficient information source. As thermal neutron field, it is the easiest way to make the field of thermally equilibrated neutrons or presenting Maxwell distribution. The heavy water facility is the most excellent among several examples. As medium speed neutron or epithermal neutron field, 1/E region of the reactor spectrum is employed. In this case, thermal neutrons are usually cut with cadmium plates. For the standard field of fast neutrons, nuclear fission spectrum is the best. It is most stable as reference spectrum though there is slight difference according to the nuclides and the incident neutron energy. Though the cadmium filter for cutting thermal neutrons is well known, the neutron field using gadolinium filter also provides the field close to the standard by utilizing the difference between cross section energy. There are crystal monochromator and velocity selector is a sense of extracting the neutrons having a certain energy, which are a little different from the standard field concept.

54452 Core engineering and core design. 1-1. Kaneko, Y. pp 1-14 of In Present status and problems of reactor neutron study. Tokyo, Japan; Atomic Energy Society of Japan (1976). (In Japanese)

The fundamental reaction quantities for maintaining the chain reaction in a reactor system are governed by the neutron cross sections averaged in the core neutron spectra. In core engineering and core design, therefore, some knowledge on the core neutron spectra is essential. After explaining significance of the research on core neutron spectra, the neutron spectra in thermal and fast neutron reactors, irradiation fields and shield engineering are described. The thermal neutron spectra in cores can be obtained by solving the thermalization formulae in the geometrical arrangement of the core materials. The fast neutron spectra strongly depend on core composition and cross sections. As neutron irradiation fields, there are those for material, fuel, RI production, and medical treatment.

54453 Convergence and error estimate of perturbation method in reactor calculations. Mitani, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 8, 413-422(Aug 1976).

A general theory of obtaining the higher order perturbation terms up to any desired order was given previously by the present author. However, the perturbation series is not always convergent in all problems of practical interest, and it is generally not so easy to obtain the convergence criteria for the perturbation method in a strict mathematical sense. When Kato's theorem developed for linear

operators in Hilbert space is applied to the problem of convergence, it can then be treated rigorously in one-group diffusion approximation. The resulting convergence criterion takes a simple form containing only the basic parameters of the reactor system. The numberical calculations for prototype and 1,000 MWe fast reactors are presented to show practical applicability of the higher perturbation method.

54454 Fluctuations of macrovariables in nonlinear systems: Langevin equation approach. Akcasu, Z.A. (Univ. of Michigan, Ann Arbor). *J. Stat. Phys.;* **16**: No. 1, 33-58(Jan 1977).

Fluctuations in nonlinear Markovian systems are studied by the Langev in equation method using system-size expansion. Langevin equations with different random sources are constructed for the description of fluctuations to varying degrees of accuracy in inverse powers of the system size epsilon. Evolution equations for the deterministic path, deviation of the mean from the deterministic path, and the variance are obtained in a nonstationary state in the lowest order of epsilon. The power spectral density for fluctuations about a stable equilibrium is calculated correct to order epsilon^2 and is compared to the exact expression for the Alkemade diode. The relaxation frequency for the decay of correlations in a critical equilibrium and the scaling law for the anomalous fluctuations are determined and compared to those obtained by Kubo.

54455 Stability analysis of a boiling loop in low-pressure operation. Yokomizo, O. (Atomic Energy Research Lab., Kawasaki, Japan); Sumida, I.; Fukuda, K.; Kobori, T.; Hirao, S. *Trans. Am. Nucl. Soc.;* **26**: 468(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54456 Pressure-induced diversion cross flow for rod bundle subchannels interconnection geometry. Tapucu, A.; Troche, N. (Institut de Genie Nucleaire, Montreal). *Trans. Am. Nucl. Soc.;* **26**: 468-469(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54457 Applications of direct nuclear-pumped lasers and gaseous core reactors. Miley, G.H. (Univ. of Illinois, Urbana). *Trans. Am. Nucl. Soc.;* **26**: 526-527(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54458 Interaction of fission fragments with gases. Deese, J.E.; Hassan, H.A. (North Carolina State Univ., Raleigh). *Trans. Am. Nucl. Soc.;* **26**: 528-529(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54459 Measurement methods for fission-fragment-generated plasmas. Schneider, R.T. (Univ. of Florida, Gainesville). *Trans. Am. Nucl. Soc.;* **26**: 530-531(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54460 Burnup calculation code for cluster-type fuel lattices, BUNDLE. Kurihara, K.; Takeda, T.; Azekura, K. (Atomic Energy Research Lab., Kawasaki, Japan). *Trans. Am. Nucl. Soc.;* **26**: 535(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54461 Analysis of BNL 1% ^{235}U exponential experiments with ENDF/B-IV data. Weiss, J.J.; Malaviya, B.K. (Rensselaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.;* **26**: 545-547(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54462 Analysis of operating reactor data with ENDF/B-IV cross sections. Bollacasa, D.; Cicerchia, J.M.; Gavin, P.H. (Combustion Engineering, Inc., Windsor, CT). *Trans. Am. Nucl. Soc.;* **26**: 547-548(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54463 Bubble worth calculations with the probability table method. Hoffman, T.J.; Petrie, L.M. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 549-551(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54464 Short-irradiation fission-product beta spectra and total energy: calculations versus experiment. Stamatelatos, M.G.; England, T.R. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 572-573(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54465 Estimate of decay energy uncertainties. Baker, S.M.; Spinrad, B.I. (Oregon State Univ., Corvallis). *Trans. Am. Nucl. Soc.;* **26**: 573-574(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54466 Calculation of neutron multiplicity for ^{235}U(n/sub th/,f). Liaw, J.R. (Univ. of Oklahoma, Norman). *Trans. Am. Nucl. Soc.;* **26**: 575-576(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54467 Failure of Wigner-Seitz approximation in the PBF reload core cell calculation. Wessol, D.E.; Wheeler, F.J. (EG and G Idaho, Inc., Idaho Fall, ID). *Trans. Am. Nucl. Soc.;* **26**: 577-578(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54468 Transport effects on nodal coupling parameters. Menezes, A.D.; Chan, G.; Ancona, A.; Becker, M.; Harris, D.R. (Rensselaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.;* **26**: 578-579(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54469 Evaluation of continuous slowing-down theory parameters in highly absorbing media. Parvez, A.; Becker, M. (Rensselaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.;* **26**: 579-580(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54470 Flux interpolation for elastic downscatter. Kidman, R.B. (Los Alamos Scientific Lab., NM); MacFarlane, R.E.; Becker, M. *Trans. Am. Nucl. Soc.;* **26**: 580-581(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54471 Sensitivity of light-water reactor parameters to uncertainties in thermal nuclear data. Ryskamp, J.M.; Harris, D.R.; Becker, M. (Rensselaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.;* **26**: 581-582(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54472 Power reactor empirical modeling using time series analysis. Strange, J.E.; Kerlin, T.W. (Univ. of Tennessee, Knoxville). *Trans. Am. Nucl. Soc.;* **26**: 583(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54473 ENDF/B-V eigenvalue calculations for UO_2 and mixed-oxide critical lattice experiments. Ozer, O. (Electric Power Research Inst., Palo Alto, CA); Fiarman, S. *Trans. Am. Nucl. Soc.;* **26**: 596-597(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54474 Sensitivity analysis of TRX-2 lattice parameters with emphasis on epithermal ^{238}U capture. Tomlinson, E.T.; de Saussure, G.; Weisbin, C.R. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 601-602(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54475 Simulation of wire activation experiments in a Pickering Reactor. Mamourian, M.; Trojan, O.A. (Atomic Energy of Canada Ltd., Ontario). *Trans. Am. Nucl. Soc.;* **26**: 605(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 54503

54476 (AED-Conf—76-660-027) **Spent fuel storage.** Huppert. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen m.b.H., Eggenstein-Leopoldshafen (Germany, F.R.)). 1976. 14p. (CONF-7609150—11). Dep. NTIS (US Sales Only), PC A02/MF A01.

From IAEA international training course on nuclear power project planning and implementation; Karlsruhe, F.R. Germany (6 Sep 1976).

6 figs.; 2 tabs.; 5 refs.

Reasons are listed for intermediate storage of fuel elements in nuclear power stations and in a reprocessing plant and the temperature and radioactivity curves of LWR fuel elements after removal from the reactor are presented. This is followed by a description of the facilities for fuel element storage in a reprocessing plant and of their functions. Futher topics are criticality and activity control, the problem of cooling time and safety systems.

54477 (BNL-NUREG—22648) **Effect of damping on the response of a non-linear system with multiple sine wave excitation.** Bezler, P.; Curreri, J.R. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 10p. (CONF-770807—14). Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

The vibration testing of non-linear systems has not received much attention in the literature. The non-linear response of the Duffing type mechanical oscillator with viscous damping and cubic type elastic-hardening characteristics subjected to a single sinusiodal excitation is known. This response has been shown to have two stable paths, one when the frequency is swept upwards past the resonant point and the other when the frequency is swept downwards. With multi-component periodic inputs, it has been shown that response frequencies involving both summed and difference combinations of the inputs can be induced when certain conditions are met regarding the relationships of the various terms in the equation. The present paper is concerned with the overall maximum response of the system of a hardening spring oscillator with one degree of freedom. The maximum response as the frequencies are swept past the natural frequency region is desired and the results are compared to those that are known for the case of a simple sine wave sweep.

54478 (NUREG—0250-1) **Program to develop acoustic emission: flaw relationship for inservice monitoring of nuclear pressure vessels. Progress report No. 1, July 1, 1976—February 1, 1977.** Hutton, P.H.; Schwenk, E.B. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Mar 1977. Contract EY-76-C-06-1830. 94p. (BNWL—2232-1). Dep. NTIS, PC A05/MF A01.

This is a laboratory research program to characterize acoustic emission (AE) from flaw growth and noise from innocuous sources in A533B Class 1 pressure vessel steel. The objectives are: characterize AE from a limited range of defects and material property conditions of concern to reactor pressure vessel integrity; characterize AE from innocuous sources (including defects); develop criteria for distinguishing significant flaws from innocuous sources; and develop an AE flaw damage model to serve as a basis for relating in-service AE to pressure vessel integrity. The purpose of the program is to build an experimental evaluation of the feasibility of detecting and analyzing flaw growth in reactor pressure boundaries by continuously monitoring for AE. A detailed program plan in the form of an analysis-before-test document has been prepared and approved.

54479 **Formulation of the diffusion creep problem.** Stevens, R.N.; Dutton, R.; Puls, M.P. (Queen Mary Coll., London). pp 60-65 of In Physical metallurgy of reactor fuel elements. Harris, J.E. (ed.). London; Metals Society (1975).

From International conference on physical metallurgy of reactor fuel elements; Berkeley, England, UK (2 Sep 1973).

See CONF-730912—.

The free energy changes accompanying diffusion in crystalline systems by various defect mechanisms are studied in detail. It is concluded that, while the potential driving diffusion in crystalline systems depends on the chemical potential of defects, the potential is independent of the particular defect or combination of defects involved in diffusion. The solutions to diffusion creep problems derived from diffusion equations using the chemical potential therefore have greater generality than is apparent in solutions found using equations in terms of the concentrations of defects. It is concluded that there are distinct advantages in retaining the fundamental form of the diffusion equations in terms of chemical potentials for diffusion creep problems. Expressions for the potential driving diffusion are derived for both single- and multi-component systems. The boundary values of the potential are considered in detail, and a simple but completely rigorous method of deriving these is given. Finally, the form of the diffusion equation for a single-component system is discussed.

54480 **Grain-boundary diffusion creep in pure metals.** Crossland, I.G. (Central Electricity Generating Board, Berkeley, Eng.). pp 66-71 of In Physical metallurgy of reactor fuel elements. Harris, J.E. (ed.). London; Metals Society (1975).

From International conference on physical metallurgy of reactor fuel elements; Berkeley, England, UK (2 Sep 1973).

See CONF-730912—.

Grain-boundary diffusion creep has been examined in various pure metals, and the results discussed with particular attention to the validity of the theoretical creep equation formulated by Coble. The results have indicated that a modified Coble equation is generally applicable to the low stress (less than 5 MN/m^4) creep of Ag, Cd, Cu, Mg, and Ni at temperatures below about 0.7 T/sub m/ (where T/sub m/ is the melting temperature). The modifications are: first, a change in the creep rate/stress relation from a Newtonian to a Bingham form, thus introducing a threshold stress below which no diffusion creep occurs; and second, an effective increase in the geometrical constant to allow for a consistent underestimation of the experimental creep rates by the theory. Other notable features relate to the occurrence of transient creep, to the influence of subgrains in increasing the creep rates, and to the suppression of diffusion creep by impurities. All these aspects are discussed with regard to the underlying mechanisms.

54481 **Comment on grain-boundary sliding and diffusion creep.** Harris, J.E. (National Physics Lab., Teddington, Eng.). pp 84-86 of In Physical metallurgy of reactor fuel elements. Harris, J.E. (ed.). London; Metals Society (1975).

From International conference on physical metallurgy of reactor fuel elements; Berkeley, England, UK (2 Sep 1973).

See CONF-730912—.

In order for coherency to be maintained during diffusional creep deformation of a polycrystalline aggregate it is necessary for grain-boundary sliding to occur concurrently. Precipitate particles, which are re-distributed during straining, may impede this sliding process and the implications of this are discussed.

54482 **Creep failure prediction from observation of microstructure in 2 1/4%—1% Mo steel.** Hale, K.F. (National Physical Lab., Teddington, Eng.). pp 193-201 of In Physical metallurgy of reactor fuel elements. Harris, J.E. (ed.). London; Metal Society (1975).

From International conference on physical metallurgy of reactor fuel elements; Berkeley, England, UK (2 Sep 1973).

See CONF-730912—.

An attempt has been made to demonstrate that the lifetime of 2¼ percent Cr—1 percent Mo steel, stressed at elevated temperatures, can be predicted by making measurements on the microstructure under accelerated creep conditions. An understanding of the creep processes involved is not considered necessary. The technique depends upon the assumption, verified by experimental observation, that the different processes operating during creep, from precipitation growth and recovery to void formation, are all equally dependent upon temperature changes given by an Arrhenius equation modified by McLauchlin. It is possible to accelerate the microstructural changes in a 2¼ percent Cr—1 percent Mo steel, a typical power plant material, by a factor of 100 through increasing the temperature by 100°C and keeping the stress constant. The remaining lifetime of power plant components could be estimated, either by taking samples of the components themselves or, alternatively, if the operational temperatures could be monitored and applied to creep tests running in parallel, by examining the test specimens.

54483 **Applications of a 3MV class electron microscope to materials science.** Fujita, H.; Tabata, T.; Sumida, N.; Yoshida, K. (Osaka Univ.). pp 202-211 of In Physical metallurgy of reactor fuel elements. Harris, J.E. (ed.). London; Metal Society (1975).

From International conference on physical metallurgy of reactor fuel elements; Berkeley, England, UK (2 Sep 1973).

See CONF-730912—.

Applications of a 3 MV class electron microscope have been examined over the voltage range 0.5—3 MV. The following phenomena in such metals as Al, Cu, Fe, Mo, W, and Au have been investigated: (a) Voltage dependence of the maximum observable thickness for dislocation images; it is shown that the maximum observable thickness at 2—3 MV is larger than the critical foil thickness, which is sufficient to observe the same phenomena as in bulk specimens, even in such heavy metals as W and Au. (b) The critical voltage of anomalous transmission of electrons at the symmetry position of reflections, which is correlated with an electron channelling parameter. (c) Electron irradiation damage, which is sensitive to the crystallographic condition of the specimens as well as to the accelerating voltage. Furthermore, the use of capsules has also been examined for the determination of liquid structure, of diffusion constants, of boundary diffusion, and of pipe diffusion along dislocation lines, and for observations of the sintering process in metal powders.

54484 Method of and an apparatus for detecting breakage of a fuel body in a nuclear reactor. Kawabe, R.; Sato, C.; Uchida, S.; Naito, M. (to Hitachi Ltd). Japanese Patent 1976-102,799/A/. 7 Mar 1975. 4p. (In Japanese).

A method for detecting the breakage of a fuel body in a short time while reducing the amount of radioactive waste gas to be taken outis described which forces a compressed gas into a pressure container, replacing the gas with a coolant while lowering the pressure of the gas, and extracting the compressed gas which has entered a broken fuel pin. A grip rod with a gripping mechanism and a door attached is caused to float and thus form a lower opening. A fuel body is accommodated through the opening within a container placed in the water. A valve is then opened to compel helium gas into a pressure container and a part of the helium gas is allowed to enter a gas plenum for a broken fuel pin. A pump is operated to feed water into the pressure container, thereby replacing the helium gas. Next, an escape valve is opened to lower the pressure within the pressure container. This allows the helium gas in the broken fuel pin to flow out of the container. The gas from the container is extracted by a sampling system.

54485 Steady-state and transient behavior of thermal sensitive power meter. Kameoka, T.; Shimotono, H.; Akiyama, M.; Furuhashi, A.; Wakabayashi, H. (Tokyo Univ. (Japan)). pp 223-245 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

A thermal sensitive power meter had been developed and tested by using Yayoi reactor of Tokyo University. A sensitive element consists of a uranium-aluminum alloy wire, enclosed by a cylindrical vacuum tube. Generated heat of the wire by nuclear fission was transfered by the thermal radiation in the reactor core. And then, thermal disturbance by convection heat from the wire in the vacuum space was neglected. Static performance of the power meter was obtained by using a glory hole of the Yayoi reactor. Transient response of the modified U-Al wire was theoretically analysed by solving a transient radiation-conduction heat-transfer equation.

54486 Characteristics, construction and use of valves for nuclear energy. Yamanari, K. (Okano Valve Mfg. Co. Ltd., Kitakyushu, Fukuoka (Japan)). *Ryutai Kogaku;* **12**: No. 5, 288-293(May 1976). (In Japanese).

The characteristics and the constructions of the valves for nuclear energy differ largely according to the types of reactors and the kinds of coolants. For the reactors being used for power generation, the valves are constructed on the basis of standard valves by incorporating the requirements for nuclear energy use secondarily, but in sodium-cooled breeder reactors and multi-purpose high temperature reactors, the valves with special constructions have been developed in various countries. A serious accident has not occurred in nuclear power stations so far, but many minor abnormalities have been reported, and those due to valves and valve-operating mechanisms amount to a quarter of them. The fault in operating function is most, and the leak from valve seats and gland packings follows. In order to reduce the probability of failure of reactors, the improvement of the reliability of valves is urgently required. As for the special valves for nuclear energy, there are main steam isolating valves, pneumatically operated relief valves, testable check valves, swing check valves for primary coolant, vacuum-breaking valves, excess flow valves and so on. The quality guarantee system in the manufacture of valves must be strengthened, but only maintenance can be relied upon regarding the secular failure of valves.

54487 Review on manufacturing process of large turbo-generator shafts. Sakabe, K. (Japan Steel Works Ltd., Tokyo). *Karyoku Genshiryoku Hatsuden;* **27**: No. 7, 647-655(Jul 1976). (In Japanese).

In March 1975, the shaft material for the 1800 MW nuclear power generator was shipped from the Japan Steel Works, Ltd. to Kraftwerk Union AG in FRG. Its weight is 247 t, and it is the largest generator shaft and the largest forging in the world. It was proved that electroslag remelting process can produce clean and sound ingots, and is promising for the production of large ingots. Supersonic flaw detection process has been incorporated in the forging process and it improves the rate of material utilization.

54488 Quality assurance in the procurement of safety-related material. Crittenden, J.A. (Tennessee Valley Authority, Knoxville, TN). *Trans. Am. Nucl. Soc.;* **26**: 417(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54489 Vibration monitor for rotating machines using an average frequency technique. Michiguchi, Y. (Atomic Energy Research Lab., Tamaku, Kawasaki); Yamada, I.; Izumi, S.; Doi, A.; Harima, T. *Trans. Am. Nucl. Soc.;* **26**: 443-444(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54490 Aging of Class 1E electronic instruments. Ismail, I.A. (Rosemount Inc., Minneapolis, MN). *Trans. Am. Nucl. Soc.;* **26**: 444-445(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54491 Response time testing of temperature sensors using a noise analysis method. Upadhyaya, B.R.; Kerlin, T.W. (Univ. of Tennessee, Knoxville, TN). *Trans. Am. Nucl. Soc.;* **26**: 445-446(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54492 Thermal performance of large UHS spray ponds. Myers, D.M. (Ford, Bacon, and Davis Utah Inc., Salt Lake City); Baird, R.D.; Shah, A.; Rogers, V.C. *Trans. Am. Nucl. Soc.;* **26**: 467-468(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54493 Multigroup data commonly available for fission and fusion reactor shielding. Roussin, R.W. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 480-482(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54494 Consistent procedures for integral experiment and basic data correlation for neutron shielding calculations. D'Angelo, A. (Univ. of Calabria, Cozenza, Italy); Oliva, A.; Palmiotti, G.; Salvatores, M. *Trans. Am. Nucl. Soc.;* **26**: 487-488(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54495 Development of an automatic radioiodine analysis system for reactor coolant. Ikeda, T. (Atomic Energy Research Lab., Kawasaki, Japan); Ogushi, A.; Doi, A.; Kamiya, Y.; Ishizuka, A. *Trans. Am. Nucl. Soc.;* **26**: 516-517(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54496 Instruments for measurement of in-core nuclear heating rates. Allen, E.J.; Kerr, H.T.; Mincey, J.F. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 605-606(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54497 Dynamics of a cylindrical shell system coupled by viscous fluid. Yeh, T.T.; Chen, S.S. (Components Technology Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439). *J. Acoust. Soc. Am.;* **62**: No. 2, 262-270(Aug 1977).

This study was motivated by the need to design the thermal shield in reactor internals and other system components to avoid detrimental flow-induced vibrations. The system component is modeled as two coaxial shells separated by a viscous fluid. In the analysis, Fluegge's shell equations of motion and linearized Navier—Stokes equation for viscous fluid are employed. First, a traveling-wave-type solution is taken for shells and fluid. Then, from the interface conditions between the shells and fluid, the solution for the fluid medium is expressed in terms of shell displacements. Finally, using the shell equations of motion gives the frequency equation, from which the natural frequency, mode shape, and modal damping ratio of coupled modes can be calculated. The analytical results show a fairly good qualitative agreement with the published experimental data. With the presented analysis and results, the frequency and damping characteristics can be analyzed and design parameters can be related to frequency and damping.

FUEL ELEMENTS

54498 (CONF-761233—1) Acoustic emission from fuel pellets in a simulated reactor environment. Kupperman, D.S.; Kennedy, C.R.; Reimann, K.J. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 6p. Dep. NTIS, PC A02/MF A01.

From Acoustic emission meeting; London, United Kingdom of Great Britain and Northern Ireland (UK) (20 Dec 1976).

Thermal-shock damage of nuclear reactor fuel pellets in a simulated reactor environment has been correlated with acoustic-emission data obtained from sensors placed on extensions of the electrical feedthroughs. Ringdown counts, rms output data, and event-location data has been acquired for experiments carried out with single pellets as well as multiple pellet stacks. These tests have shown that acoustic-emission monitoring can provide information indicating the onset and the extent of cracking.

54499 (SGAE—2425) Determination of the burn up and differentiation of the fission yields of uranium-thorium-fuels. Goroncek, K.; Falta, G.; Pichlmayer, F. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). Feb 1975. 9p. (In German). (PH—180/75, CH—157/75). Dep. NTIS (US Sales Only), PC A02/MF A01.

The burnup of highly enriched and highly burned up (U, Th) O_2 fuels has been determined by two different and unrelated methods. The results for the fuel burnup calculated from the ratio of the uranium isotopes is compared with the results from the method of the stable molybdenum isotopes. The number of Mo-95 atoms enables the calculation of the total burnup; the respective fission yields of U-233 and U-235 are obtained by the ratio of Mo-95 to Mo-100 isotopes. This method requires fewer assumptions than the former but it is more laborious because one has to determine the content of uranium and molybdenum of the samples. Moreover the burnup data obtained from the gamma-spectroscopic determination of Cs-137 are given.

54500 Physical metallurgy of reactor fuel elements. Harris, J.E.; Sykes, E.C. (eds.). London; Metals Society (1975). 483p. (CONF-730912—). 24.00.

From International conference on physical metallurgy of reactor fuel elements; Berkeley, England, UK (2 Sep 1973).

Included are sixty-four papers. Each paper has been separately abstracted and indexed for the Energy Data Base. (DG)

54501 Irradiation damage in alpha-zirconium and zirconium-titanium solid solutions. Buckley, S.N.; Manthorpe, S.A. (Atomic Energy Research Establishment, Harwell, Eng.). pp 127-131 of In Physical metallurgy of reactor fuel elements. Harris, J.E. (ed.). London; Metal Society (1975).

From International conference on physical metallurgy of reactor fuel elements; Berkeley, England, UK (2 Sep 1973).

See CONF-730912—.

Various anomalies occur in the irradiation of zirconium, particularly the low incidence of void formation. Various suggestions have been made for either failure to produce voids or mechanisms for their disappearance. Work on the Zr—Ti system which shows complete miscibility and sensitivity to anisotropic growth is reported, together with its extension to pure zirconium and studies on various impurities in trace amounts. Other properties related to the irradiation studies were also investigated.

54502 Effect of surface roughness on the heat transfer from a circular cylinder to the cross flow of air. Achenbach, E. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente). *Int. J. Heat Mass Transfer;* **20**: No. 4, 359-369(Apr 1977).

The influence of surface roughness on the heat transfer of a circular cylinder to the cross-flow of air has been studied. The Reynolds number was varied from 2.2×10^4 to 4×10^6. The variation of the roughness parameter was $0 <$ ksub(s)/d $< 900 \times 10^{-6}$. The tests have been performed for the boundary condition T approximately const. For each of the rough cylinders, the static pressure distribution together with the local and total heat transfer have been measured. Particular attention has been paid to the transition from a laminar to a turbulent boundary layer as a function of Reynolds number and roughness parameter.

54503 Fluid flow and heat transfer in tubes with internal square rib roughening. Beger, F.P. (Queen Mary Coll., London (UK)); Whitehead, A.W. (Nuclear Power Co. (Whetstone) Ltd. (UK)). *J. Br. Nucl. Energy Soc.;* **16**: No. 2, 153-160(Apr 1977).

Friction factors, velocity profiles and Stanton numbers have been measured in pipes internally roughened with well defined sharp square transverse ribs. Values of the pitch to height ratio (p/e) of the ribs of 3.0, 5.0, 7.2 and 10.0 were investigated at a constant rib height to pipe diameter ratio (e/d) of 0.02. The Reynolds numbers tested covered the range 6×10^3 to 2×10^5 in tests with heating and 6×10^3 to 3×10^5 in isothermal tests. Using the present experimental results together with data from the literature, relations have been suggested for the roughness function $Ar(e^+)$ and the heat transfer function $G(e^+, Pr)$. With the help of these functions the friction factor and Stanton number can be calculated in the ranges: $6 \times 10^3 < Re < 2 \times 10^5$; $5 < p/e < 40$; $0.01 < e/d < 0.04$; $0.7 < Pr < 40$, for $e^+ < 40$, for the given type of internally roughened surface.

54504 Mechanical analysis of the dilatation-induced pellet-cladding interaction. Knight, N.F. Jr.; Kamat, M.P. (Virginia Polytechnic Inst. and State Univ., Blacksburg). *Trans. Am. Nucl. Soc.;* **26**: 461-462(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54505 Calculated microscopic depletion in UO_2 and MO_2 fuel rods. Edenius, M. (AB Atomenergi, Nykoeping, Sweden). *Trans. Am. Nucl. Soc.;* **26**: 602-603(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

CONTROL SYSTEMS

54506 Gas-cooled nuclear reactor and method to control the reactor. Cramer, H.; Brandes, S.; Nicolai, R.; Schoening, J.; Verfuerth, H.; Wachholz, W. (to Hochtemperatur-Reaktorbau G.m.b.H). German(FRG) Patent 2,451,748/A/. 6 May 1976. 21p. (In German).

4 figs.

It is proposed to design the shut-down devices of a gas-cooled pebble-bed reactor in such a way that two shut-down systems, independent and different from one another, will be provided. A number of the reflector rods form a first shut-down system for partial shutdown or scram, and the core absorber rods form a second system controlling the complete or long-time shut-down. Configuration and function of the control units are described in detail.

54507 Process computer systems for fossil and nuclear power plants. Iida, H.; Matsumura, J.; Nakamura, H.; Nakano, Y. (Hitachi Ltd., Tokyo (Japan)). *Hitachi Hyoron;* **58**: No. 6, 441-444(Jul 1976). (In Japanese).

It is of growing importance that the process computer systems play the role of the automatic control systems in thermal power plants. While in nuclear power plants, it is considered as indispensable that reactor behavior is grasped with computers for improving the plant safety. The application of computers to thermal power generating units has been developed in four stages, namely plant performance monitor, sequence monitor, operation automation system, over-all total automation. The over-all total automation system is in the development stage. In nuclear power plants, though the plant control instrumentation and operation systems are significantly different depending upon the reactor types, computers are mainly employed to air at grasping accurately the complicated reactor conditions in real time in light water reactors which form 77% of existing nuclear power generating units now in operation.

54508 Recent trends of control and instrumentation system engineering for BWR nuclear power plant. Otaka, H.; Aoki, R.; Hara, K.; Ikehara, M.; Neda, T. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). *Toshiba Rebyu;* **31**: No. 8, 691-698(Aug 1976). (In Japanese).

The application of electronics and computer technology has brought a remarkable change to the control and instrumentation systems in BWR nuclear power plants. The principle of "as low as practicable" and the severe requirement of safety have had a significant impact on BWR plant engineering. Presented here are the trends and some of the writers' engineering activities on the main control room design, the solid-state control rod drive system and the in-core monitor.

54509 370/CSMP dynamics simulation of PWR power plant. Filho, H.A.; Hukai, R.Y.; Schad, V.R. (Instituto de Energia Atomica, Sao Paulo, Brazil). *Trans. Am. Nucl. Soc.;* **26**: 439-440(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54510 Performance improvement of the B and W integrated control system. Russell, C.D.; Winks, R.W. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.;* **26**: 513(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54511 Control rod worths in a simulated radial parfait LMFBR core. Hartman, A.K.; Hitchcock, J.T.; Stewart, S.L. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.;* **26**: 538-539(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 55110

54512 (ORNL/NUREG/TM—72) **Critical evaluation of the nonradiological environmental technical specifications. Volume 4. San Onofre Nuclear Generating Station, Unit 1.** Adams, S.M.; Cunningham, P.A.; Gray, D.D.; Kumar, K.D. (Oak Ridge National Lab., Tenn. (USA)). 10 Aug 1976. Contract W-7405-ENG-26;NRC-INA-40-550-75. 98p. Dep. NTIS, PC A05/MF A01.

A comprehensive study of the data collected as part of the environmental Technical Specifications program for Unit 1 of the San Onofre Nuclear Generating Station (SONGS 1) was conducted for the Office of Nuclear Regulatory Research of the U.S. Nuclear Regulatory Commission. The program included an analysis of the hydrothermal and ecological monitoring data collected during 1975. The hydrothermal analysis includes a discussion of models used in plume predictions prior to plant operation and an evaluation of the present hydrothermal monitoring program. The ecological evaluation was directed toward reviewing the strengths and weaknesses of the various sampling programs designed to monitor the planktonic, benthic, and nektonic communities inhabiting the inshore coastal area in the vicinity of San Onofre.

54513 **Nuclear power and environment.** Prakash Chandra. *Usp. Fiz. Nauk;* **1**: No. 2, 21(Feb 1977).

Published in summary form only.

SITING

54514 **Current USAEC seismic requirements for nuclear power plants.** Mehta, D.S. (Bechtel Power Corp., Gaithensburg, Md (USA)). *Bull. Jpn. Pet. Inst.;* **12**: No. 2, 65-73(Jun 1975).

10 refs.

The principal seismic and geologic considerations which guide the USAEC in its evaluation of the suitability of proposed sites for nuclear power plants and plant design bases are set forth as design criteria in the AEC regulatory guides. The basic requirements of seismic design and analysis for seismic Category I structures, components, and systems important to public safety have been established in the USAEC regulatory guides and Code of Federal Regulations. It is pointed out that the current state-of-art techniques, best available technology, and additional studies in the field of earthquake engineering can be utilized to resolve seismic concerns. The seismic design requirements for nuclear plants to withstand postulated earthquakes can be standardized and this will be a significant milestone in the continuation of the Nuclear Standardization Program.

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 54043, 54053

54515 **Radioactive waste discharge by nuclear power plants and fuel reprocessing plants.** Ruf, M.; Huebel, K.; Herrmann, H.; Luensmann, W. *Wasserwirtschaft;* **66**: No. 10, 287-293(Oct 1976). (In German).

10 tabs.; 11 refs.

Nuclear power plants and fuel reprocessing plants are depended to release some fission and activation product activities with the radioactive waste waters into the environment. Data are given about the activity inventory in the fuel elements of various types of nuclear power plants, the appearence of fission and activation products in the primary cooling circuits as well as about the emission of radioactive substances together with the waste waters of nuclear power plants and of fuel processing plants. Besides this the ecological effects of the removal of radioactive waste waters into surface waters and the additional radiation burden for people are discussed and compared with the radiation protection orders which are available for the Federal Republic of Germany.

54516 **Evaluation of tritium recycle and buildup in a pressurized water reactor.** Smith, C.B. (Environmental Protection Agency, Wheaton, MD). *Trans. Am. Nucl. Soc.;* **26**: 518-519(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

CHEMICAL AND THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 55531

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 54439, 54467, 54581

54517 (CONF-770611—3) **Instruments for measurement of in-core nuclear heating rates.** Allen, E.J.; Kerr, H.T.; Mincey, J.F. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 4p. Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; New York, New York, United States of America (USA) (12 Jun 1977).

The design and testing of three prototype calorimeters for the measurement of in-core nuclear heating rates in selected materials are described. The calorimeters were constructed and tested in the Oak Ridge Research Reactor.

54518 (HEDL-TME—77-17) **High ^{240}Pu FTR/EMC experiments and analysis: cross section preparation.** Ombrellaro, P.A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Mar 1977. Contract EY-76-C-14-2170. 47p. .

The procedure used to generate a set of 42 energy group resonance and spatially self-shielded cross sections derived from high-^{240}Pu fuel compositions is described. The cross sections have been developed for use in analyzing experiments performed in the high-^{240}Pu fuel compositions of the FTR-Engineering Mockup Critical, developed for the study of characteristics of the FTR loaded with light water reactor recycled plutonium. Some cross section results for ^{239}Pu and ^{238}U derived from the high-^{240}Pu compositions are compared with corresponding results derived earlier from low-^{240}Pu fuel compositions.

54519 (ORNL/TM—5929) **Bulk Shielding Facility quarterly report, July, August, and September of 1976.** Hurt, S.S. III; Lance, E.D.; Thomas, J.R. (Oak Ridge National Lab., Tenn. (USA)). Jun 1977. Contract W-7405-ENG-26. 28p. Dep. NTIS, PC A03/MF A01.

The BSR operated at an average power level of 1637 kW for 50.05 percent of the time during July, August, and September. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. The BSR was operated at low and variable power during this quarter for 27.327 hours as part of the training programs for nuclear reactor operator trainees from Memphis State University. The PCA was also used in the above-mentioned training programs and was operated on six occasions when the Oak Ridge Associated Universities or Memphis State University students actively participated in training laboratories.

54520 (SAND—76-9311) **Development of a (U,Zr)C-graphite pulsed reactor fuel element.** Reuscher, J.A.; Karnes, C.H.; Marion, R.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 4p. (CONF-770807—4). Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

A new core is being designed to improve the performance of the Annular Core Pulse Reactor (ACPR). This design utilizes a two region core with the inner region containing high enthalpy fuel elements around the 228 mm diameter central irradiation cavity. An outer core region of uranium-zirconium hydride fuel elements is placed around the high-enthalpy inner core region to provide an adequate negative temperature coefficient for the entire core. A program has been conducted to develop a high-enthalpy fuel element using a graphite matrix fuel containing (U-Zr)C solid solution particles. The program has successfully developed a (U, Zr) C-graphite fuel element with a high volumetric enthalpy which can be used in a water cooled pulse reactor. Extensive tests have demonstrated the feasibility and safety of the fuel element design.

54521 (TID—27619) **LOFT integral test system: preliminary component design description for the pressurizer.** (Idaho National Engineering Lab., Idaho Falls (USA)). Dec 1970. Contract EY-76-C-07-1570. 188p. Dep. NTIS, PC A09/MF A01.

Information on the LOFT pressurizer and its associated equipment is presented concerning the design requirements and functions, physical description, safety considerations, principles of operation, maintenance principles, and interfaces.

54522 (TID—27664) **LOCE core differential pressures.** Saffell, B.F. Jr. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 27 Nov 1972. Contract EY-76-C-07-1375. 6p. Dep. NTIS, PC A02/MF A01.

A subcooled blowdown analysis of the LOFT reactor system has been performed. The pressure transients throughout the reactor system have been computed for three 8 inch schedule 160 LOCEs - inlet, outlet, and simultaneous inlet-outlet. The break opening time utilized for this analysis was 0.001 second. This subcooled blowdown analysis yielded core differential pressure transients for each of the three LOCEs studied. The maximum positive and negative pressure

differences across the core are summarized. To obtain an estimate of the compressive load on the fuel assemblies, the maximum negative core ΔP is converted to a force and added to the holddown spring preload. The results are presented for the control, center, and corner fuel assemblies.

54523 (TID—27665) **Flow rate calculations for LOFT core support barrel outlet nozzle: reactor vessel outlet nozzle.** Gottula, R.C. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 10 Mar 1972. Contract EY-76-C-07-1375. 5p. Dep. NTIS, PC A02/MF A01.

Preliminary calculations have been made to determine the flow rate through the gap between the LOFT core support barrel outlet nozzle and the reactor vessel outlet nozzle. Calculations were made for gap thickness from zero to 0.1 inches. A plot of flow rate through the gap vs gap thickness is presented. A plot of the percentage of full flow (4.3×10^6 lbm/hr) vs gap thickness is also presented.

54524 (TID—27667) **LOFT core flow study.** Fujita, R.K. (EG and G Idaho, Inc., Idaho Falls (USA)). Jul 1975. Contract EY-76-C-07-1570. 81p. Dep. NTIS, PC A05/MF A01.

The results are presented of the LOFT core flow study to determine the LOFT core flow rates and coolant temperatures so that the LOFT cladding temperature response can best represent that of a typical LPWR. The time to reach CHF is recognized as an important indicator of core behavior. Therefore, computer models of the LOFT and LPWR cores were prepared to determine the time required for each core to reach CHF under different sets of thermal-hydraulic plenum conditions. It is concluded that the LOFT clad temperature response is similar to that of an LPWR when the LOFT initial hot leg fluid temperatures are near the LPWR temperatures (610°F to 618°F). The initial LOFT core flow rates do not effect its core response in relation to time to CHF. A delay in the time to reach CHF was observed for the LOFT fuel pin for certain core conditions caused by a rewetting of the fuel pin early in the transient. CHF was reached earliest in the LOFT core near the core midpoint while in the LPWR, the earliest CHF location was in the upper portion of the core.

54525 Accuracy of the experimental methods used in the investigations of reactor characteristics on critical assemblies with slightly enriched UO_2 fuel and light water moderator. Pt. 2. Dabrowski, C. (Institute of Nuclear Research, Warsaw (Poland)). *Nukleonika;* **19**: No. 10, 869-890(1974). (In Russian).

To illustrate the degree of difficulty connected with the derivation of valuable experimental results in the investigation of light water lattices with slightly enriched UO_2 fuel and to justify the accuracy recommended in Part 1 of this paper, remarks on the experimental inaccuracy sources have been given. The remarks concern the material buckling B^2, d(rho)/dH parameter, intracell parameters delta[28], rho[28], delta[25], MCR, xi as well as the SI spectral indices and related activation measurements. The most important sources of the random and systematic uncertainties have been described and exemplary values of these uncertainties have been quoted in tables.

54526 Improvement of fuel use in the reactor RA. Krsticj, D.; Bulovicj, V.; Milosevicj, D.; Maksimovicj, Z. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)); Boreli, F. (Belgrade Univ. (Yugoslavia). Electrotehnicki Fakultet). *Teion Kogaku;* **13**: 19-38(1975).

24 refs., 5 figs., 5 tables.

More intensive use of fuel in the RA reactor was achieved by applying a more suitable fuel exchange program. According to this, the medium parts of the fuel channels are loaded with complete unused fuel. Some of the partly used fuel elements from the middle are moved to the periphery of the channels for further burn up. Refuelling program was calculated on the basis of one-group perturbation theory. High efficiency of such a program has been proved by calculating its burn up amounts of ^{106}Ru, ^{134}Cs and ^{137}Cs isotopes. A gamma spectrometer with the semiconductor Ge(Li) detector was used.

54527 Optimization study of peak thermal neutron flux in moderators of advanced repetitive pulse reactors. Asaoka, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment); Watanabe, N. pp 643-656 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

In achieving a high peak thermal neutron flux in hydrogenous moderators installed in repetitive pulse reactors, the core-moderator arrangement can play as much an important role as the moderator design itself. However, the effect of the former has not been adequately emphasized to date, while a rather extensive study has been made on the latter. The present study concerns with a core-moderator system parameter optimization for a repetitive accelerator pulsed fast reactor. The results have shown that small differences in the arrangement resulting from the optimizations of various parameters are significant and the effects can be summed up to give an increase in the peak thermal flux by a factor of about two.

54528 Generation of thermal neutron flux peak. 3-2. Hayashi, M. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). pp 84-92 of In Present status and problems of reactor neutron study. Tokyo, Japan; Atomic Energy Society of Japan (1976). (In Japanese)

High-intensity thermal neutron field is very attractive to the researchers who utilize thermal neutrons. The problem in the generation of thermal neutron flux peaks concerned with both reactor physics and engineering is how to leak neutrons out of reactor cores and trap them while maintaining the high-efficiency chain reaction. In this connection, the following matters are described: the composition of the core, the shape of the core, and the relation between available neutron quantity and flux peak. Concerning the shape of the core, the large ratio of surface area to volume is desirable to obtain easy neutron leakage. The integrated quantity of available neutrons increases when the thermal neutron flux peak is made within the outer reflector region, rather than in the incore moderator region.

54529 Reliability analysis of nuclear design methods for fast pulse reactors. Hirata, M.; Nishimura, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). pp 27-43 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

The nuclear design methods using a multi-group cross section set for solving the Boltzmann transport equation have been used to predict the neutronic characteristics of fast pulse reactors. This paper reviews the processing method of a multi-group constants, design methods and their applications for calculating some neutronic characteristics of fast pulse reactors. The comparison of these calculations with experiments is presented.

54530 Prompt alpha and reactivity measurements on fast metal assemblies. Mihalczo, J.T. (Oak Ridge National Lab., Tenn. (USA)). pp 205-222 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

This paper reviews the prompt neutron decay and reactivity measurements that have been performed for uranium (93.2 wt% ^{235}U) metal assemblies and correlates events in a detector in the assembly with those in a chamber containing the spontaneously fissioning isotope, ^{252}Cf, which provides neutrons that initiate fission chains in the assembly. The theory is reviewed and the results of measurements in both the time and the frequency domains are presented. The results are also compared with other measurements.

54531 High intensity neutron source for fast pulsed booster reactor. Takahashi, H. (Tokyo Inst. of Tech. (Japan)). pp 113-128 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

The deuteron stripping reaction for making a high intensity neutron source of the fast pulsed booster reactor is discussed in comparison with the method of using the proton (p,xn) reaction. Although the former one has lower neutron production efficiency than the latter, the neutron source is concentrated in the terms of space direction and energy. This method has advantage over the (p,xn) reaction as the outside neutron source for the fast pulsed booster reactor.

54532 High grade power from fissioning gases. NASA research on fissioning plasmas and nuclear-pumped lasers. Thom, K. (Space Nuclear Systems Office (AEC;NASA), Washington, D.C. (USA)). pp 607-630 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

Fissioning plasmas are the gaseous fuel in high-temperature cavity reactors that originally were conceived for nuclear rocket propulsion in space. For achieving a specific impulse up to 5000 sec, the nuclear fuel must burn at a temperature in excess of 10,000 K. For criticality, the uranium particle density must be not less than the

molecular density of gases at standard conditions. In previous investigations it was, therefore, assumed that the fissioning plasma is optically thick. However, in gaseous matter the energy release of fissions can lead to ionization and excitation that deviate from Maxwell-Boltzmann distributions. This condition can be exploited for the direct conversion of fission fragment energy into coherent light. Recent research has culminated in the first experimental nuclear-pumped lasers. At about the same time, a program of gaseous fuel reactor experiments with enriched uranium hexafluoride was started. Criticality tests were conducted with uranium foils simulating the gaseous fuel. Gaseous uranium hexafluoride will be used in a series of forthcoming experiments.

54533 Simulation study on the dynamics and control of Japan Linac Booster. Wakabayashi, J.; Yoshikawa, H. (Kyoto Univ., Uji (Japan). Inst. of Atomic Energy). pp 309-332 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

The conceptual design study of Japan Linac Booster(JLB) is promoted by the technical research committee of JLB. As a part of above project, the authors studied the dynamics and control of JLB in analytically A promising new approach to dynamic problems is proposed, in which the matrix iterative method is utilized to describe the dynamic behavior during one pulse cycle, as well as between the adjacent pulse cycles. The pulsed criticality condition, the steady state operation chracteristics and power excursion characteristics are easily calculated by this method, whatever the shape of reactivity pulse may be. The quantitative examinations are made using the design parameter of JLB. In order to limit the initial thermal shock at the start-up period of JLB, the authors propose a method of program control. In this study, the simplified reactor core dynamic model which is obtained by regression analysis technique is successfully utilized.

54534 Fast pulsed reactor kinetics. Theory and experiment. Wimett, T.F. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 355-381 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

Solutions to the simple transient response equation of reactor kinetics are completely inadequate to predict behavior of a fast burst reactor in the presence of external neutron reflection. The one-point kinetics model has been extended to adequately include neutron reflection along with effects of elastic waves in the reactor fuel excited by short duration bursts. Some recent data obtained with Godiva IV are included to demonstrate the validity of this approach.

54535 Cold neutron sources with a reactor and an electron Linac. 5-1-1. Utsuro, M. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). pp 155-167 of In Present status and problems of reactor neutron study. Tokyo, Japan; Atomic Energy Society of Japan (1976). (In Japanese)

The cold neutron source is a device producing the neutrons mainly of energy about 5 MeV - 0.1 MeV. Its fundamental function is to moderate the energy of the neutrons from a reactor, for example, to cold neutron region by means of nuclear scattering with a cooled substance. After explaining the ideal cold moderating compound, problems in the cold neutron sources for reactors and Linacs are described, followed by brief comparison between the two. Here as the ideal one, a moderator compound giving the ideal form of energy distribution due to the excellent moderation is assumed. With a reactor, a liquid moderator is used to deal with the problem of radiolysis. With a Linac, soljd methane gives the highest gain of cold neutrons.

54536 Safety aspects of pulsed YAYOI and Japan Linac Booster. An, S.; Oka, Y. (Tokyo Univ. (Japan). Nuclear Engineering Research Lab.); Wakabayashi, J. pp 525-552 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

The paper consists of two parts. The first part is concerned with safety aspects of pulsed YAYOI. Reactivity pulsed operation of YAYOI is performed with reactivity oscillating devices. Inherent safety characteristics due to dilation of metal fuel, a small amount of f.p. buildup, reactor operation preserving fuel integrity and experience on transient experiments are the principal basis for safety assurance. Conditions for pulsed operation, namely, maximum allowable temperature, maximum number of repetition of pulsed operation and so on are derived from the consideration on the integrity of fuel. Instrumentation and control systems are reinforced by displacement meter in the core, interlock system, special timer for pulsed operation, additional scram conditions and reactivity meter. Accident analysis and safety evaluation indicate the conservative safety features of the facility. Concerning pulsed operation of YAYOI combined with Linac, special attention must be given to the design of Linac target placed in the core. In the second part are described the principal guide-lines and basic ideas for safety design of Japan Linac Booster (JLB). JLB is a U-Mo fueled and sodium cooled fast reactor with rotatingrotating reflector and Linac target in the core.

54537 Status of fast pulsed reactors in Japan. An, S. (Tokyo Univ. (Japan). Nuclear Engineering Research Lab.). pp 17-24 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

YAYOI is open to joint use of all universities in Japan and LB type pulsed reactor program is also a joint project of university union in Japan. The preliminary experiments for pulsed operation of YAYOI was started in 1973 and the pulsed operation was attained last December. The pulsed operation combined with Linac is also promised next year. Four kinds of pile oscillators are available as reactivity varying devices for YAYOI. Each oscillator can be used alone or combined with each other to make many different modes of reactivity addition. This reactivity pulsing procedure is a original one which has not yet been explored in the world. Linac program started in 1974 and the main machine is scheduled to be completed in this fiscal year. The repetitive fast pulsed reactor in Japan is based on the original concepts and is the combination of Booster, i.e., a subprompt critical reactor and electron Linac.

54538 Safeguard and some aspects of safety of the IBR-2 reactor. Ananiev, V.D.; Blokhintsev, D.I.; Bunin, B.N.; Zinkevich, S.V.; Frank, I.M. (Joint Inst. for Nuclear Research, Dubna (USSR)). pp 573-601 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

In the first part of the paper are briefly described the expected values of parameters and peculiarities of the periodically pulsed research reactor IBR-2. The requirements for safeguard of a pulsed fast reactor are stated (such as permanent control of reactivity modulator condition, control of each power pulse, reactivity control, short scram time). In the second part the IBR-2 safety system structure and the main controlled reactor parameters are described. The discussed items are ranges of reactor power, where a given control channel operates reliably, trip signal levels, scram time and so on. The data of safety blocks and their drivers are also available. The third part of the paper is devoted to the experimental check on the main unit of IBR-2, responsible for its safety, the reactivity modulator (RM). The data on axial and phase vibrations of the moving reflectors and on vibrations after the loss of sealing of RM jacket are given. In addition, the expected influence on reactivity fluctuations is estimated.

54539 Solution pulse reactor SILENE. Barbry, F.; Mangin, D.; Vanel, M. (CEA Centre d'Etudes de Valduc, 21 - Is-sur-Tille (France)). pp 657-674 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

SILENE is an experimental homogeneous pulsed reactor using a solution of uranyl nitrate as fuel. It produces bursts whose characteristics can be modified by varying the insertion of reactivity. Radiation leakage can also be modified by surrounding core with shields. The core is constituted from a 360 mm diameter annular vessel; a rod, being used for insertion of reactivity, is moving through the central cavity. Different kinds of excursions can be obtained by varying the withdrawal rate of the rod. Thus the reactor can have a 2200 p.c.m. (asymptotically equals 3 $) reactivity step in removing the rod at high speed. It generates a burst with the following specifications: period = 2.4 ms, maximum power asymptotically equals 2.4×10^{19} fissions/s (asymptotically equals 770 Megawatts), energy in pulse = 1.6×10^{17} fissions (5 Megajoules). During the peak power, very interesting performances can be reached in the central cavity: neutron fluence = 4.10^{14} n/cm^2, maximum instantaneous flux = 6.10^{16} n/cm^2/s, integrated gamma dose = 4.10^5 R, and gamma dose rate = 2.10^{11} R/h.

54540 Pulsed reactors as thermal neutron sources. Brugger, R.M. (Missouri Univ., Rolla (USA)). pp 419-446 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

The pulsing or bursting of a reactor allows time-of-flight methods to be used for the thermal neutron experiments which realizes a gain over steady-state neutron source for the same average power. Since the maximum average power is one of the major limits to more intense neutron sources, pulsed reactors hold the potential for 1,000 times more peak power and thus effective flux and experimental capability than do the steady-state reactors. Examples of operating pulsed reactors used for thermal neutron research are the IBR-30 at Dubna and the booster at Harwell. Because of their advantages, other pulsed reactors have been proposed; while new ones continue to be proposed. As used for thermal neutron research, the past experience and future potential of pulsed reactors is reviewed. The position of fast burst reactors in the overall scheme of future thermal neutron sources is discussed.

54541 Operational characteristics of the CALIBAN fast pulse reactor. Cortella, J.; Reberol, R.; Vanel, M. (CEA Centre d'Etudes de Valduc, 21 - Is-sur-Tille (France)). pp 157-170 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

CALIBAN is a FPR operated at CEA-Valduc Center since 1971. It has been designed as a fast neutron irradiation source and its environment is specific for this utilization. To date, it delivered more than 400 bursts and the fuel integrated about 5.10^{19} fissions. The main characteristics are: - cylindirical core 113 kg U 235 - Mo 10% alloy - integrated dose in a burst in the central 2.5cm diam cavity:3.10^{14}n.cm^{-2} - integrated dose in a burst outside of the core:5.10^{13} n.cm^{-2} - pulse width:50μs A special effort was made in measuring the spectrometric and dosimetric neutron and gamma characteristics. Some results are presented.

54542 Conceptual core design of a repetitively pulsed reactor. Hirata, M. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). pp 631-641 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

A dynamic booster concept being coupled with a neutron multiplication system mechanically modulated of the reactivity and an electron linac has been investigated for obtaining higher intensed neutrons. This paper reviews the conceptual core design that emerged from the study. The neutronic and thermo-hydraulic characteristics of the core are discussed.

54543 Some experiences and plans on reactor safety research by NSRR. Ishikawa, M.; Saito, S.; Fujishiro, T.; Tomii, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). pp 487-506 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

The NSRR (Nuclear Safety Research Reactor) has been critical since June 30th 1975. The NSRR is a modified TRIGA-ACPR (Annular Core Pulse Reactor), in which some 4.7 dollar pulsing operation is possible to produce the test fuel melting in the sodium circumstance as well as in the water one inside a capsule or a loop. So far, several fuel failure tests using the atmospheric pressure capsule filled with water have been made simulating the reactivity initiated accident in the light water moderated power reactor. The fuel failure occurred in the case of about 230 cal/gUO_2 energy insertion in the fuel, and the cladding was quite brittle after the test. In the case of 290 cal/gUO_2 energy insertion the test fuel broke into five large pieces. Several hundreds of tests are planned to determine the threshold energy limits for fuel failure and investigate fuel behaviours, fuel failure mechanisms, fuel-coolant interaction and so on, for the water reactor fuels and the fast reactor fuels, respectively.

54544 Status of fast pulse reactors in the U.S.A. Long, R.L. (New Mexico Univ., Albuquerque (USA)). pp 9-16 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

After a brief review of the historical development of fast pulse reactors in the U.S.A., this paper describes the physical characteristics, operating data, and reactor utilization of the six operable U.S.A. fast pulse reactors. These include the Aberdeen Pulsed Radiation Facility Reactor (APRFR), the White Sands Fast Burst Reactor Facility (FBRF), the Oak Ridge Health Physics Research Reactor (HPRR), and the Sandia Pulsed Reactors -II and -III (SPR-II and SPR-III). Significant differences among the reactors are identified and the reader is referred to earlier meeting proceedings for detailed descriptions of each reactor.

54545 Dynamic thermomechanical behavior of fuel element of YAYOI. Miya, K. (Tokyo Univ. (Japan). Nuclear Engineering Research Lab.); Yagawa, G. pp 271-285 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

The fuel of a fast burst reactor is subject to vibrations occasioned by rapid temperature rise when the reactivity in the core is suddenly increased. This paper covers an analysis of such fuel vibration in the fast neutron source reactor "YAYOI" under pulsed operation, with use made of the finite element method, and adopting as parameters the rate of temperature rise and the spatial temperature distribution. In addition, effect of a anisotropy of the fuel which is composed of grains on the mechanical behavior is investigated numerically. An analytical solution is also obtained assuming that the fuel is under plane stress, for comparison with the results derived by the finite element method. Agreement between the two results is very good within the bounds of the plane stress condition. The results indicate that the amplitudes of dynamic displacement and stress increase with rising rate of energy release. The relation between these quantities is presented.

54546 Design and initial performance of the Sandia Pulsed Reactor III. Reuscher, J.A.; Estes, B.F. (Sandia Labs., Albuquerque, N.Mex. (USA)). pp 89-112 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

The Sandia Pulsed Reactor-III (SPR-III) is a new fast pulsed reactor which has recently undergone initial testing at Sandia Laboratories. SPR-III is a uranium-10 weight percent molybdenum fuel assembly with a 17.78 cm irradiation cavity similar in design to SPR-II which has been in operation since 1967. The basic SPR-III design utilizes the same split-core configuration which has been proven with SPR-II; however, SPR-III uses external reflectors for control and external bolts to hold the fuel plates together. The core consists of sixteen fuel plates with an inside diameter of 17.78 cm, an outside diameter of 29.72 cm, and a core height of 31.9 cm. The fuel mass is about 227 kg of fully enriched uranium-10 weight % molybdenum alloy. SPR-III has completed the initial series of startup tests which included the critical experiment, zero and low-power tests, and pulse testing. The reactor design and results from the initial testing program are described in this paper. A portion of the startup experiments with SPR-III have been completed and this paper discusses the more important aspects of the initial testing program.

54547 Dynamic thermomechanical behavior of the Sandia Pulsed Reactor III. Reuscher, J.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). pp 333-353 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

The theoretical and measured mechanical behavior of SPR-III during pulse operation is described. The core was instrumented with noncontacting displacement transducers and the oscillations of the fuel plates and support structure were recorded. A method for calculating the fuel stresses using surface oscillations is described. The dynamic, thermal stress results were obtained from a two-dimensional, finite difference analysis which included temperature dependent properties.

54548 Utilization of fast pulse reactors in nuclear and radiolysis. Shiokawa, T. (Tohoku Univ., Sendai (Japan). Faculty of Science). pp 409-417 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque

(USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

By utilization of intense pulsed neutron beams, new various aspects in nuclear and radiochemistries should be developed. On line charge spectrometry of recoil atoms after nuclear reactions and the analysis of the followed chemical reactions of the recoil atoms with neutral molecules become possible by the utilization. Their information will contribute very much to elucidate many "black-boxes" in the present feature of recoil chemistry. And also many new researches will become capable as a fission products reactor, a tritium reactor and a knock-on proton reactor. By a fission product reactor, the basic study of recoil implantation will be carried out and the mechanism of it elucidated. By a tritium reactor, a tritium source such as LiF is adopted and elucidate the intermediate species with neutral organic molecules. And by a knock-on proton reactor, the resultant of knock-on excited proton reaction with other organic molecules will become measurable. The most actual application will be done in the field of radioactivation analysis. Utilization of pulsed beams of high flux of fast and thermal neutrons will serve to the more sensitive analysis of many element by the detection of short-lived activated radionuclides having half-lives less than one minute.

54549 Rapid response and wide range neutronic power measuring systems for fast pulsed reactors. Sumita, K.; Iida, T. (Osaka Univ., Suita (Japan). Faculty of Engineering); Wakayama, N. pp 183-204 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

This paper summarizes an investigation on design principles of the rapid, stable and wide range neutronic power measuring system for fast pulsed reactors. The picoammeter, the logarithmic amplifier, the reactivity meter and the neutron current chamber are the items of investigation. In order to get a rapid response, the method of compensation for the stray capacitance of the feedback circuits and the capacitance of signal cables is applied to the picoammeter, the logarithmic amplifier and the reactivity meter with consideration for the stability margin of a whole detecting system. The response of an ionization current chamber and the method for compensating the ion component of the chamber output to get optimum responses high pass filters are investigated. Statistical fluctuations of the current chamber output are also considered in those works. The optimum thickness of the surrounding moderator of the neutron detector is also discussed from the viewpoint of the pulse shape deformation and the neutron sensitivity increase. The experimental results are reported, which were observed in the pulse operations of the one shot fast pulsed reactor "YAYOI" and the one shot TRIGA "NSRR" with the measuring systems using those principles.

54550 Time characteristics of various pulsed cold neutron sources. 5-2. Sumita, K. (Osaka Univ. (Japan)). pp 172-181 of In Present status and problems of reactor neutron study. Tokyo, Japan; Atomic Energy Society of Japan (1976). (In Japanese)

After explaining the means of evaluating pulsed cold neutron sources with the so-called F.O.M. values, the following matters are described: constitution of pulsed cold neutron sources; neutron energy variation and time characteristics in cold moderators; and a combination-type pulsed cold neutron source and the energy time-dependence characteristics. As for the pulsed cold neutron sources, there are two types: cold moderation of the neutrons from a reactor, then chopping the resulting beam; and, pulsed neutron beam from such as an accelerator, followed by its cold moderation. For the cold moderators, hydrogen-containing systems are generally used. The pulsed cold neutron source of combined moderators is intended to maximize the F.O.M. value.

54551 Irradiation technique in research reactor. 2-3. Umei, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). pp 59-67 of In Present status and problems of reactor neutron study. Tokyo, Japan; Atomic Energy Society of Japan (1976). (In Japanese)

Recent neutron applications require high techniques and accuracy. Among such examples in the research reactors in JAERI, it is intended to introduce the production of ^{99}Mo and the neutron irradiation of silicon single crystal. The domestic production of ^{99}Mo, the parent nuclide of ^{99}Tc whose demand has rapidly increased in recent years as the radioactive pharmaceuticals for scintigram or movement test, is strongly requested. The most usual production method of ^{99}Mo is ^{98}Mo (n, γ) ^{99}Mo method using high neutron flux, but it is being changed to the method using ^{235}U(n, f). In 1975, the irradiation facilities for ^{99}Mo production using the new method have been installed in JRR-2 and JRR-3 reactors. The conventional production method of silicon single crystals has depended upon the floating zone method. However, the neutron transmutation doping has begun to be noticed because of the difficulty in the uniform distribution of dopant in a single crystal. The method utilizes the nuclear reaction of ^{30}Si (n, γ) ^{31}Si sup($(-\beta)$) ^{31}P, though the abundance of ^{30}Si in natural silicon is approximately 3%. The method is being experimented in JRR-4 reactor. As the recent trend, it is required to grasp the behavior of samples during irradiation, and for the purpose, the establishment of irradiation technique with in-core instrumentation is necessary.

54552 Design aspects of fast neutron source reactor YAYOI as fast pulsed reactor. Wakabayashi, H.; Furuhashi, A.; An, S.; Tamura, T. (Tokyo Univ. (Japan). Nuclear Engineering Research Lab.). pp 45-73 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

University of Tokyo research reactor YAYOI which means Prosperity in Japanese is intended as dynamic fast source reactor as well as a stationary one like AFSR and HARMONIE. It is equipped with reactivity adding devices with both slow and quick action, and a LINAC PNS operating conjunction with the reactivity adding devices. The unique idea of fly-through type reactivity addition into the core lends itself to minimizing back ground neutrons born due to delayed multiplication. Some explanation of design aspects of fast pulsed reactor of YAYOI are presented.

54553 Design concept of Japan Linac Booster. Wakabayashi, J. (Kyoto Univ., Uji (Japan). Inst. of Atomic Energy). pp 75-88 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

The development program of the repetitive-accelerator fast-pulsed reactor (JLB; Japan Linac Booster) was authorized by Japan Science Council at 1971. JLB will be operated as a common use research facility of the university union of Japan. The conceptual design study is started from 1971. JLB is rotating reflector type sodium cooled fast pulsed reactor and its design target is given as follows, 1) Average power is 2 MW 2) Effective peak thermal neutron flux is about 1 x 10^{16}nv/cm^3 3) Pulse neutron width is about 10 μsec 4) Maximum repetitive cycle is 200 pps Though the conceptual design is not completed yet, the outline of the present situation of above studies are presented in this report.

54554 Measurement of fast neutron spectra. 1-2. Kimura, Itsuro (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). pp 15-28 of In Present status and problems of reactor neutron study. Tokyo, Japan; Atomic Energy Society of Japan (1976). (In Japanese)

The present status of the techniques for the measurement of fast neutron spectra is reviewed with particular attention to the recent activities in Japan. The first section of this report defines the energy range of fast neutrons, and various techniques are classified into four groups. In the following sections, recent development in each group is reviewed. The first part is the integral method represented mainly by the activation method. The variation of this method is shortly reviewed, and some results of the spectrum measurement for JRR-4 (a thermal research reactor) and YAYOI (a fast neutron source reactor) are presented together with the results of computed spectra. The second part is the method of proton recoil. The improvement of a proportional counter by Ichimori is shortly reviewed. The use of liquid scintillator is also discussed together with the experimental and computational results of YAYOI benchmark spectra of fast neutrons transmitted through the layers of iron. The utilization of n-α or n-p reaction as a sandwitch counter is discussed in the third part. Measured and calculated spectra in the FCA (a fast critical assembly) core are presented as examples. The method of time-of-flight is discussed in the fourth part. Recent developments in Japan such as the method with a double-scintillation counter are shortly presented together with its block diagram.

54555 Polarizing neutron guide using laminated mirrors. Drabkin, G.M.; Okorokov, A.I.; Shchebetov, A.F.; Borovikova, N.V.; Gukasov, A.G.; Korneev, D.A.; Kudryashov, V.A.; Runov, V.V. (B. P. Konstantinov Leningrad Institute of Nuclear Physics, Academy of Sciences of the USSR, Gatchina). *Sov. Phys. - Tech. Phys. (Engl. Transl.)*; 22: No. 1, 117-120(Jan 1977).

A polarizing neutron guide using 50Co 50Fe mirrors with an absorbing sublayer is described. The construction of the guide is described. Results found in tests in a VVR-M reactor (Leningrad Institute of Nuclear Physics) are reported. The neutron flux leaving the guide, with a cross-sectional area of 1.6 x 30 mm, is 1.7x10^7 neutrons/(cm^{2}xsec) at a reactor power level of 16 MW. The average value of the polarization over the spectrum is 0.95 at a small angular width of the beam leaving the guide or 0.97 at a large width.

54556 Acoustic monitoring of the IRT-10 test in the TREAT reactor. Bobis, J.P.; Doerner, R.C.; Carey, W.M.; Gavin, A.P. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* 26: 442-443(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54557 Fast Flux Test Facility operator training simulator. Hunt, S.A. (Westinghouse Hanford Co., Richland, VA). *Trans. Am. Nucl. Soc.;* 26: 513-514(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54558 FFTF fuel failure detection and characterization by cover-gas monitoring. Miller, W.C. (Westinghouse Hanford Co., Richland, WA). *Trans. Am. Nucl. Soc.;* 26: 514-515(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54559 WSMR burst reactor irradiation cavity enlargement thermal shock stress analysis. Hull, W.C. (New Mexico State Univ., Los Cruces); Mulholland, G.P.; Welch, D.L.; De La Paz, A. *Trans. Am. Nucl. Soc.;* 26: 523-524(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54560 Evaluated cross sections and fission spectrum average for ^{64}Zn(n,p)^{64}Cu. Ottewitte, E.H. (EG and G Idaho, Inc., Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* 26: 597-599(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

REFER ALSO TO CITATION(S) 54591

54561 Irradiation for material testing. 2-4. Mizuho, M. (Japan Atomic Energy Research Inst., Oarai, Ibaraki. Oarai Research Establishment). pp 68-76 of In Present status and problems of reactor neutron study. Tokyo, Japan; Atomic Energy Society of Japan (1976). (In Japanese)

The typical materials to be tested by irradiation are iron and steel materials for reactor pressure vessels and graphite as the material for high temperature gas cooled reactors. Irradiated neutron dose is evaluated with the induced activity of the fluence monitor (mainly ^{54}Fe or ^{58}Ni) simultaneouly irradiated with samples. However, since this monitor has the threshold energy of approximately 2 MeV, the neutron spectra of lower energy must be evaluated by calculation. Specifically for graphite, the energy range from 0.1 to 1.0 MeV is required. In JMTR, the one-dimensional Sn code ANISN calculation is applied to the above region, which seems to give the accuracy of about 10%. In fuel irradiation testing, the fundamental quantity for evaluation is the fission rate of the fuel expressed generally in calorific value per unit length (linear output W/cm). For the settlement of detailed irradiation conditions, the two-dimensional diffusion calculation is generally carried out. Major problems are spectrum correction layer and region dependence. Two methods of activated foil integration and reactor noise analysis are practical for the reactor output measurement of low power. Utilization of fission foil is considered as a method to avoid the above and other problems. Accuracy of such estimation is evaluated as approximately +- 8% (1 sigma) at present.

PROPULSION REACTORS

54562 (AD-B—008941) Nuclear aircraft feasibility study (executive summary). Report for 1 Mar 74—7 Feb 75. Amos, M.W.; Butt, J.S.; Campbell, B.L.; Diehl, R.G.; Fanning, W.J. Jr. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio (USA). School of Engineering). Mar 1975. 37p. (GSE/SE—75-1-Summ). NTIS PCA03/MF A01.

Master's thesis. See also Volume 1, AD-B—008943L.

The objective of this study was to assess the feasibility of applying nuclear propulsion to aircraft in performance of the Air Force Mission. This was accomplished by using a systems approach with the system divided into six areas: (1) Mission Selection, (2) Required Mission Avionics, (3) Aircraft Design, (4) Propulsion System Design, (5) Public Safety, and (6) Cost. The overriding constraint of the study was the assumption that technology would limit an aircraft gross weight to 2,000,000 lbs in the 1990's. At this gross weight, an aircraft built using conventional construction methods and powered by a liquid metal cooled nuclear reactor, but using only chemical fuel for takeoff, would have a negative payload of 120,000 lbs. If the aircraft were constructed using advanced composites and a liquid metal cooled reactor with chemical augmentation for takeoff, the payload would be 470,000 lbs. By switching the liquid metal reactor for a similarly constructed helium cooled reactor, the payload would drop from 470,000 lbs to 210,000 lbs. For each individual in the U. S., the risk of being killed by the radioactive particles associated with one of the airborne 574 MW reactors, would be 9.34 X 10 to the - 8th power per year, which is less risk than that of being struck by lightning. The 52,000 hr airframe life cycle cost was estimated to be $26.4 billion for 60 aircraft.

54563 Development of nuclear powered ship in Japan. Sato, H. (Japan Nuclear Ship Development Agency, Tokyo). *Genshiryoku Kogyo;* 22: No. 6, 20-24(Jun 1976). (In Japanese).

The development of nuclear merchant ship in Japan was started in 1955 by the establishment of Nuclear Ship Study Group, and since then, the investigation, test and research on nuclear ships have been continued. As a result, a nuclear ocean observation and supply ship was designed for trial. Researches were carried out also in JAERI and Institute for Technical Research of Ships. Meanwhile, the nuclear icebreaker Lenin was completed in Soviet Union in 1959, the nuclear ship Savannah set out for maiden voyage in U.S. in 1962, and the construction of the nuclear ore carrier Otto Hahn was prepared in FRG. Japan Nuclear Ship Development Corp. was established in 1963, and started the design and construction of the first nuclear ship in Japan, Mutsu. The basic policy in the construction is the improvement of nuclear ship technology, the securing of safety, and the use of domestic technologies as far as possible. The progress of the design, construction and test of the Mutsu is described. Owing to the problem of radiation leak, the development of nuclear ships stagnated for a while, but the nuclear plant of the Mutsu demonstrated the expected performance in the functional test, land criticality test and zero output test, and it is expected that the bud of the independent development brought up so far can bear valuable fruit. The independent development of marine nuclear reactors should be continued by selecting the way most suitable to Japan.

54564 Clear role for nuclear power. *S. Afr. Min. Eng. J.;* 88: No. 4120, 81,83,85(Sep 1976).

Studies of the world's mineral resources have pointed to the rapid depletion of fossil fuels within a short time span. It is therefore necessary to regard the development of nuclear facilities as vital to industrialisation. This influenced the decision to establish South Africa's first nuclear power station at Koeberg. The initial fuel charge will be provided by overseas countries, because South Africa's enrichment plant will not be commissioned early enough. As a major producer of uranium South Africa has undertaken its own experimental and developmental work on an enrichment process. What is certain is that the electrical energy requirements will be high but within the capacity of Escom.

54565 Gaseous uranium core reactor. Helmick, H.H.; Barton, D.M.; Lowry, L.L. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* 26: 525(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54566 Status of uranium plasma research. Hohl, F. (Langley Research Center, Hampton, VA). *Trans. Am. Nucl. Soc.;* 26: 525-526(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54567 UF_6 technology for gas core reactors. Latham, T.S. (United Technologies Research Center, East Hartford, CT). *Trans. Am. Nucl. Soc.;* 26: 527-528(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

REACTOR SAFETY

REFER ALSO TO CITATION(S) 54031, 54047, 54069, 54363, 54366, 55318, 55535

54568 (ANL—77-10) Light-water-reactor safety research program. Quarterly progress report, October—December 1976. Sachs, R.G.; Kyger, J.A. (Argonne National Lab., Ill. (USA)). Mar 1977. Contract W-31-109-ENG-38. 117p. Dep. NTIS, PC A06/MF A01.

This progress report summarizes the Argonne National Laboratory work performed during October, November, and December 1976 on water-reactor-safety problems. The following research and development areas are covered: (1) loss-of-coolant accident research: heat transfer and fluid dynamics; (2) transient fuel response and fission-product release program; (3) mechanical properties of Zircaloy containing oxygen; and (4) steam-explosion studies.

54569 (BMI-NUREG—1972) **Steam—water mixing and system hydrodynamics program. Task 4. Quarterly progress report, January 1, 1977—March 31, 1977.** Carbiener, W.A.; Cudnik, R.A.; Flanigan, L.J.; Carr, J.A.; Denning, R.S. (Battelle Columbus Labs., Ohio (USA)). May 1977. 48p. Dep. NTIS, PC A03/MF A01.

Experimental studies are being conducted in scaled models of a four loop pressurized water reactor at pressures to 75 psia to extend the understanding of steam-water interaction phenomena and processes associated with a loss-of-coolant accident. A 2/15 size, low pressure (75 psia) facility was completed during this quarter and testing was initiated. A portion of the initial series of quasi-steady state penetration tests, with no hot walls or cold leg steam, was completed. The early, partial results are presented and compared to 1/15 data. The data trends observed in the 2/15 facility are similar to the 1/15 size based on the preliminary comparisons. The penetration curves show reasonable agreement between the 1/15 and 2/15 sizes using the j^* parameters as the scaling basis. Confirmation of this observation awaits additional comparisons and an analysis of the data uncertainties which are still in progress. Efforts were continued on the development of a data correlation based on the 1/15 data. Additional data were considered to expand the data base and extend the parameter ranges. Efforts were concentrated on the examination of pressure effects that potentially are included in the empirical constants. The implementation and checkout of RELAP4 MOD5 on the Battelle CDC CYBER 73 computer system was completed and sample problems successfully run.

54570 (BNWL—2212) **Core thermal model: COBRA-IV development and applications.** Stewart, C.W.; McMonagle, C.A.; Thurgood, M.J.; George, T.L.; Trent, D.S.; Cuta, J.M.; Seybold, G.D. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1977. Contract EY-76-C-06-1830. 91p. Dep. NTIS, PC A05/MF A01.

The objective of the Core Thermal Model Development program currently in progress at the Battelle Pacific Northwest Laboratory is to develop numerical simulation methods for evaluating thermal hydraulic performance of water-cooled nuclear reactor cores and other components during postulated accident conditions. The primary thrust of this program to date has been continued development of the COBRA computer code as a tool for multidimensional transient simulation applicable to either PWR or BWR cores. COBRA-IV incorporates numerous numerical features which significantly extend computational capabilities beyond that of the widely used COBRA-III-C. One unique feature of COBRA-IV is that it maintains the subchannel connection logic used by COBRA-III-C but applies this logic in a manner similar to the finite-difference methods common in numerical hydrodynamics.

54571 (CENPD—138(Suppl.2)) **PARCH: a FORTRAN-IV digital program to evaluate pool boiling, axial rod and coolant heatup.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Jan 1977. 21p. Engineering, Inc., Windsor, CT.

This report details changes made to C-E's ECCS version of the PARCH code resulting from a new NRC requirement concerning blowdown heat transfer. The report also documents some minor changes which were made to improve the code methodology. Sensitivity studies performed in order to determine the effects of the changes on peak clad temperature and clad oxidation are also documented in this report.

54572 (CONF-760822—P2, pp 737-748) **Removal of radioactive aerosols from the post accident atmosphere of an LWR-containment.** Haury, G.; Schoeck, W. (Kernforschungszetrum Karlsruhe, Germany). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The computer code NAUA has been developed to model the removal of the airborne radioactive particles in the post accident atmosphere of an LWR-containment. It calculates the aerosol processes coagulation, diffusion, sedimentation and thermophoresis, the steam condensation on the particles, and significant thermodynamic effects such as heat removal by the containment spray system. With the first version NAUA-Mod 1 calculations have been done which show the dominant role of the condensation process. The number concentration and the size of the droplets affect very strongly the rate of subsequent coagulation between droplets and the remaining dry particles. This effect is further enhanced by temperature decrease due to spraying. The paper discusses the structure and potential of the NAUA code, and presents the results of a parametric study on the important removal effects. Some problems of the physical behavior of the aerodispersed system in the post accident LWR-atmosphere are discussed which cannot be solved by the modelling alone.

54573 (CONF-760822—P2, pp 749-760) **Gas clean-up system for vented containment.** Kovach, J.L. (Nuclear Consulting Services Inc., Columbus, OH). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Component selection and sizing analysis was performed for both operational and post accident vented containment for light water reactors. The criteria used was the decrease of pressure and retention of significant health hazard isotopes which would be present in the containment after a loss of coolant accident. Time-pressure curves were developed for different vent volumes together with fission product capacity for the various components of the system. The analysis indicates that the design of post accident venting systems is feasible and the protection afforded can justify the cost of the system. Two types of operation were analyzed; treatment external to the containment and vent to the atmosphere, and treatment external to the containment with recirculation to the containment.

54574 (CONF-760822—P2, pp 784-810) **Control room ventilation intake selection for the floating nuclear power plant.** Walker, D.H.; Nassano, R.N.; Capo, M.A. (Offshore Power Systems, Jacksonville, FL). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

To assist in the design of the control room air supply for a floating nuclear plant, a comprehensive wind tunnel measurements program, employing scale models of two floating nuclear power plants located within a scale model of a typical breakwater, was performed at the Colorado State University under the direction of Offshore Power Systems. The purpose of the program was to provide data for: (1) selecting locations on the standard plant for the two alternate control room ventilation intakes, and, (2) determining applicable dispersion factors between the release locations and the selected intakes required for hazard analyses. This paper describes the measurements program and the methods employed by Offshore Power Systems in analyzing the experimental data that lead to the selection of the intake locations and the values of dispersion factors for control room hazard analyses.

54575 (CONF-760822—P2, pp 811-828) **Evaluation of control room radiation exposure.** Byoun, T.Y.; Conway, J.N. (Burns and Roe, Inc., Oradell, NJ). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The development and practical test applications of a computer program "AID" (Accident Inhalation Dose) are discussed. The "AID" computer code calculates the external cloud doses (gamma, whole body and beta skin) and the resultant inhalation doses after a radiological release based upon site meteorological data and a wide range of possible ventilation and filtration designs.

54576 (CONF-760822—P2, pp 884-897) **Aerosol behavior in LMFBR accidents: results of TUNA experimental program and comparison with PARDISEKO code.** Schikarski, W.O. (Kernforschungszentrum Karlsruhe, Germany). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Aerosol behavior in contained vessels is of high significance for LMFBR safety analysis. In the TUNA program UO_2-particle concentrations have been measured in a 2.2 m^3 and a 0.022 m^3 vessel as function of time. A corresponding computer code PARDISEKO III was developed which describes the concentration time function for different geometries and gas temperatures. The aerosol processes most important for aerosol behavior have been identified. The significant experimental results are reported and compared with theory. Open problems in the complete description of aerosol behavior in LMFBR containments are discussed.

54577 (CONF-760822—P2, pp 927-944) **Evaluation of in-vessel emergency air cleaning systems for an LMFBR.** Hinds, W.C.; Mallove, E.F.; First, M.W. (Havard Air Cleaning Lab., Boston). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The goal of direct application in-vessel air cleaning systems is to reduce the two hour integrated dose leaking from a containment vessel after a design basis accident by rapidly reducing airborne sodium aerosol concentration within the vessel. This reduction in concentration is achieved by direct action on the entire containment volume rather than by a more conventional recirculating clean-up loop. Strategies that have been evaluated include: increased sedimentation by enhanced agglomeration using powder dispersal, acoustic energy, or turbulence, and powder scavenging. Experiments were conducted by burning metallic sodium in a 90 m^3 chamber to achieve aerosol concentrations up to 10 gm/m^3. The time decay of the airborne mass was measured by sequential filter sampling and the effectiveness of each enhancement method was evaluated by comparison with decay profiles of untreated aerosols. Experiments with induced turbulent agglomeration show 2-hour dose reduction factors (DRF's) up to 43. Under the same scale turbulence conditions it is likely that a similar DRF would be achieved in a 30 m high containment vessel. Powder dispersal scavenging tests in the same chamber showed 2-hour DRF's up to 7.2—a performance level which would also be duplicated in a 30 m high containment vessel.

54578 (CONF-761039—2) **Boiling and two-phase flow problems in liquid metal fast breeder reactor safety analysis.** Fauske, H.K. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 16p. Dep. NTIS, PC A02/MF A01.

From Two-phase flow and heat transfer symposium; Fort Lauderdale, Florida, United States of America (USA) (18 Oct 1976).

Accident energetics problems generic to the liquid metal cooled fast breeder reactor concept are briefly discussed, including the concern over energetic recriticality and energetic fuel-coolant interaction events following a low probability core disruptive accident. Application of well-known two-phase flow and nucleation concepts suggest that (1) disrupted core material would experience boilup even at decay heat power levels and would not be prone to slump or compact causing energetic recriticality and (2) since the contact temperature between the molten oxide fuel and liquid sodium is well below the spontaneous nucleation temperature for sodium, large-scale energetic fuel-coolant thermal interactions (vapor explosions) should not occur.

54579 (CONF-770611—12) **Calculation of reactivity changes due to bubble collapse.** Hoffman, T.J.; Petrie, L.M. (EG and G Idaho, Inc., Idaho Falls (USA)). 1977. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; New York, New York, United States of America (USA) (12 Jun 1977).

Calculations based on Behrens' method indicate that a substantial increase in reactivity may accompany the collapse of a large number of small bubbles in an LMFBR core. More sophisticated transport approaches to this problem have encountered several difficulties: the large number of bubbles requires many mesh points; the desired effect can easily be masked by the movement of fuel to regions of greater (or lesser) importance; the reactivity is desired for a random distribution of spherical bubbles. This paper describes a transport approach to this problem which avoids the above difficulties by using the "sub-group" or "probability table" method.

54580 (COO—2571-8) **Improvement and verification of fast reactor safety analysis techniques. Progress report, January 1, 1977—March 31, 1977.** Barker, D.H.; Bott, T.F.; Wheeler, P.A.; Lamonica, L.; Jackson, J.F. (Brigham Young Univ., Provo, Utah (USA). Dept. of Chemical Engineering). 1977. Contract EY-76-S-02-2571. 286p. Dep. NTIS, PC A13/MF A01.

Experimental validation of the VENUS-II disassembly code through analysis of the Kiwi-TNT, SNAPTRAN-2, and SNAPTRAN-3 tests has been completed. Work-energy calculations based on VENUS-I results were compared to experimental work-energy measurements of the above tests. Good agreement was found between calculation and experiment. A VENUS-II and SIMMER-I comparison study was completed. When point kinetic neutronics are used in SIMMER-I, disassembly calculations match closely. The slight discrepancy noted between the two codes arose from the differences in hydrodynamic modeling used in the codes. A methodical investigation of chemical reactions was made to identify reactions that can simulate pool dispersion in the transition phase of an HCDA. Three reactions (e.g., dilution of sulfuric acid in water, neutralization of sulfuric acid with sodium hydroxide, and the reaction of DMSO and acetyl chloride) were selected for further investigation. The analytical procedure of finding heating rates, given data available in the literature, was applied to the dilution and neutralization reactions selected. The heating rate of the DMSO - acetyl chloride reaction was determined by the use of a titration calorimeter.

54581 (GEFR—00029) **Risk analysis application to FFTF: second cycle.** Feiler, K.G.; Hurd, D.E. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Jan 1977. Contract EY-76-C-03-0893-013. vp. .

This report documents work performed under Subtask B, Risk Analysis Application to FFTF—Second Cycle, of the LMFBR Risk Assessment Methods Task. The objective of the study was to improve the credibility of the First Cycle Assessment by developing and applying probabilistic analytical and numerical procedures in areas of the First Cycle where estimates were made by judgement. The report presents the models, results, and conclusions of the study.

54582 **Radiation safety and environmental protection in nuclear power plant operation.** Hladky, E. (Vyskumny Ustav Energeticky, Jaslovske Bohunice (Czechoslovakia)). *Tech. Pr.;* **28**: No. 10, 21-25(Oct 1976). (In Czech).

The concept of radiation protection is discussed and the risks are indicated of nuclear power plant operation. The means are briefly tackled of preventing the release of radioactivity into the environment, such as biological shielding, containment, etc. The effect of the normal operation of a nuclear power plant on the radiation burden of the environment is pointed to. It is shown that while the maximum contribution to the radiation burden by a typical 1,000 MW PWR power plant is about 1 mrem per year, the natural background alone is higher by at least two orders of magnitude. The systems of control and of radiation monitoring are also briefly discussed to show how the health risks of the population living in the neighbourhood of a nuclear power plant are minimized.

54583 (LA-NUREG—6797-SR) **Numerical study of downcomer flow dynamics. Status report, July—December 1976.** Amsden, A.A.; Butler, T.D.; Harlow, F.H. (Los Alamos Scientific Lab., N.Mex. (USA)). May 1977. Contract W-7405-ENG-36. 27p. Dep. NTIS, PC A03/MF A01.

The two-phase flow of steam and water can be studied analytically only by means of mathematical models that approximate in some statistical sense the incredibly complicated details of the contorting flow field. A heuristic basis is discussed here for several of the simplifications that are currently used for the modeling of such a flow in the downcomer around the core of a nuclear reactor. In particular, we discuss the representation of mass and momentum exchange between phases, and briefly describe the way these models are used in the numerical solution technique of the K-TIF computer code. Several downcomer calculations are described and compared with experimental data, with results that confirm the usefulness of the modeling at this highly preliminary stage.

54584 (LA-UR—77-1135) **Hydro-elastic calculations of the dynamic response of a reactor to a sudden loss of coolant.** Dienes, J.K.; Hirt, C.W.; Stein, L.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 11p. (CONF-770807—5). Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

In the design of pressurized water reactors (PWRs) it is necessary to assure that a breach of the primary coolant circuit would not lead to failure of the structure supporting the core. Because of the complexity of the problem, designers have used a number of approximations in estimating the structural loadings that are generally believed to lead to conservative designs. The current research effort at the Los Alamos Scientific Laboratory is intended to take advantage of advanced computer codes and the largest computers to analyze simultaneously the fluid motion that accompanies a loss of coolant accident (LOCA), the structural motion resulting from the transient pressure differentials, and the effect of structural motion of the pressure in the fluid. Progress on the study of this problem is described.

54585 (NEDC—21465) **Preliminary report: in-plant safety/relief valve discharge load test, Monticello Plant.** Chang, H.C. (comp.). (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Dec 1976. 96p. Electric Co., San Jose, CA.

This preliminary report covers the results of the test program of safety/relief valve (SRV) discharge load phenomena and the effects upon the Mark I primary containment torus structure of the Monticello Nuclear Power Plant. The objectives of the test were to provide a data base for verifying/improving analytical models and to measure the structural response of the torus to SRV discharges. Objectives, instrumentation, and test plan are described. Results of continuing data evaluation will be included in the final report scheduled for publication later in 1977.

54586 (NEDO—13468) **Mark II Pressure Suppression Test Program, Phase II and III tests.** Grafton, W.A.; McIntyre, T.R.; Ross, M.A. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). Mar 1977. 225p. Electric Co., San Jose, CA.

Twenty-three blowdown tests were performed in Phases II and III of the Mark II Pressure Suppression Test program to evaluate pool dynamics effects in the Mark II containment geometry. The tests utilized the steam generator and drywell of the Pressure Suppression Test Facility (PSTF) and the Temporary Tall Test Tank (4T) as a combination suppression pool and wetwell air

space. The vent geometry was a single 20-inch vertical pipe, which, with the earlier 24-inch data from the Phase I tests, yields a data set which approximates the range of pool to vent area ratios of all Mark II containments. Particular emphasis was placed on pool response to a simulated loss-of-coolant accident, including pool swell, wetwell pressurization, vent flow, pool thermal response, and chugging. Data correlations and phenomenological explanations of the observed data are included.

54587 (NEDO—21052) **Maximum discharge rate of liquid-vapor mixtures from vessels.** Moody, F.J. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). Sep 1975. 12p. Electric Co., San Jose, CA.

A discrepancy exists in theoretical predictions of the two-phase equilibrium discharge rate from pipes attached to vessels. Theory which predicts critical flow data in terms of pipe exit pressure and quality severely overpredicts flow rates in terms of vessel fluid properties. This study shows that the discrepancy is explained by the flow pattern. Due to decompression and flashing as fluid accelerates into the pipe entrance, the maximum discharge rate from a vessel is limited by choking of a homogeneous bubbly mixture. The mixture tends toward a slip flow pattern as it travels through the pipe, finally reaching a different choked condition at the pipe exit.

54588 (NUREG—0090-6) **Report to Congress on abnormal occurrences, October—December 1976.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Management Information and Program Control). 15 Mar 1977. 27p. Dep. NTIS $4.00.

Section 208 of the Energy Reorganization Act of 1974 identifies an abnormal occurrence as an unscheduled incident or event which the Nuclear Regulatory Commission determines to be significant from the standpoint of public health or safety and requires a quarterly report of such events to be made to Congress. This report, the seventh in the series, covers the period from October 1 to December 31, 1976. The NRC has determined that during this period: (1) There were two abnormal occurrences at the 63 nuclear power plants licensed to operate. One event involved improper control rod withdrawals resulting in an unplanned reactor criticality. The second is a generic event pertaining to feedwater nozzle cracking in Boiling Water Reactors. The incidents had no actual impact on public health or safety. (2) There were five abnormal occurrences at other licensee facilities. The occurrences involved overexposures to radiography personnel; one event also involved high radiation levels in unrestricted areas. This report also contains information updating previously reported abnormal occurrences. This report does not contain information on activities in those states which have entered into agreements with the NRC for the assumption of certain regulatory authority pursuant to Section 274 of the Atomic Energy Act, as amended. Future reports will include Agreement State licensee activities as soon as procedures can be implemented.

54589 (ORNL/NUREG/NSIC—133) **Index to Nuclear Safety. A technical progress review by chronology, permuted title, and author. Vol. 11, No. 1—Vol. 17, No. 6.** Cottrell, W.B.; Klein, A. (Oak Ridge National Lab., Tenn. (USA)). 23 Feb 1977. Contract W-7405-ENG-26. 105p. Dep. NTIS, PC A06/MF A01.

This index to Nuclear Safety covers articles in Nuclear Safety Vol. 11, No. 1 (Jan.-Feb. 1970), through Vol. 17, No. 6 (Nov.-Dec. 1976). The index includes a chronological list of articles (including abstract) followed by KWIC and Author Indexes. Nuclear Safety, a bimonthly technical progress review prepared by the Nuclear Safety Information Center, covers all safety aspects of nuclear power reactors and associated facilities. The index lists over 350 technical articles in the last six years of publication.

54590 (PB—265795) **Soil-structure interaction effects at the Humboldt Bay power plant in the Ferndale earthquake of June 7, 1975.** Valera, J.E.; Seed, H.B.; Tsai, C.F.; Lysmer, J. (California Univ., Berkeley (USA). Earthquake Engineering Research Center). Jan 1977. 53p. (UCB/EERC—77/02). NTIS, PC A04/MF A01.

The distribution of ground motions and structural response in the Humboldt Bay Nuclear Power Station during the Ferndale earthquake of June 7, 1975 is analyzed. Based on a knowledge of the motions developed at the ground surface in the free-field, computations are made using an idealized complete interaction procedure based on finite element analysis, to determine the characteristics of the motions likely to develop at the base of the Refueling Building at a depth of 85 ft below the ground surface and within the Refueling Building at a depth of 85 ft below the ground surface and within the Refueling Building at the ground surface level. The computed motions are shown to be in reasonably good agreement with those recorded at these locations in the same earthquake. In addition, the recorded motions are compared with those computed by an analysis procedure which generally meets existing requirements of the Nuclear Regulatory Commission and it is shown that the regulatory requirements lead to an entirely adequate but not excessively conservative margin of safety based on the motions recorded in this event.

54591 (UNI-SA—38) **Comparison of a full-scale non-nuclear reactor blowdown with a RELAP4 model.** Madsen, D.R. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 6 Jan 1977. Contract EY-76-C-06-1857. 16p. (CONF-770904—1). Dep. NTIS, PC A02/MF A01.

From TDFM group meeting on heat fluid flow in water reactor safety; Manchester, United Kingdom of Great Britain and Northern Ireland (UK) (13 Sep 1977).

During preoperational testing of the N Reactor primary and emergency cooling systems in 1964, a full scale isothermal blowdown of the primary loop was performed. A recently developed RELAP4 model of the N Reactor system was used to match the behavior of the system during the blowdown. The agreement between the test data and the RELAP4 results are generally good with discrepancies less than 15 percent.

54592 **Protection and safety of nuclear power stations.** *DYWIDAG - Ber.;* No. 1, 28-30(1976). (In German).

With figs.

The extreme requirements for the safety of nuclear power stations set tasks to the civil engineer which, resulting from dynamic load assumptions, among other things also demand the development of novel special concrete steels with a high elastic limit (here: DYWIDAG thread tie rod) for singly reinforced members.

54593 **Genshiryoku anzensei kenkyu no genjo. (Present status of reactor safety studies, 1976).** Tokyo, Japan; Japan Atomic Energy Research Inst. (1976). 76p. (In Japanese).

Research works in JAERI of nuclear power safety are described with emphasis on the works in the past one year. The works in JAERI are in two aspects, i.e. nuclear reactor safety and environmental safety. In the former are: reliability and integrity of the reactor core and the pressure boundaries, credible accidents such as loss-of-coolant and reactivity, and evaluation/analysis of these phenomena. In the latter are: evaluation of environmental radioactivities, and radioactive wastes management.

54594 **Fast reactor safety studies using VIPER.** Findlay, J.R.; Tait, J.H.; Venables, H.; Moreton-Smith, M.J. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment); McTaggart, M.H. pp 553-572 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

Irradiated fast reactor fuel samples exposed in a burst reactor such as VIPER to a heating transient release the fission products accumulated during their original irradiation. By sealing the sample in a capsule, the pressure generated can be measured and an "equation of state" analogous to the vapour equation used in a Bethe-Tait analysis to represent the fuel behaviour can be derived. Because the VIPER spectrum is hard, it is necessary to moderate the neutron fluence to near thermal to achieve the required fission densities and so the heat input to melt UO_2. To avoid sink and self-shielding effects which would depress the fission rate within a large sample the sample is restricted to a disc 10 mm diameter and 1-2 mm thick. In practice, the irradiated fuel is so brittle that the sample comprises approximately 1 g of small pieces of fuel mostly less than 1 mm dimensions. The measurement and interpretation problems associated with two types of capsule which have been developed are discussed. The diaphragm type is fitted with strain gauges to measure its deflection as a function of internal pressure.

54595 **Transient heat transfer in turbulent flow with time-dependent heat input.** Kawamura, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). pp 383-404 of In Proceedings of US/Japan seminar on fast pulse reactors. Long, R.L. (ed.) (New Mexico Univ., Albuquerque (USA)); An, Shigehiro; Wakabayashi, Hiroaki (eds.). Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1976).

From US/Japan seminar on fast pulse reactors; Tokai, Ibaraki, Japan (19 Jan 1976).

Information on transient variation of heat transfer coefficient is required for accident analysis of a power reactor or thermal design of a pulse reactor. In all the analyses or designs, however, the heat transfer coefficient is assumed equal to its steady-state value. This quasi-static assumption is examined in the present paper. The transient energy equation is solved numerically for turbulent annular flow. Variations of the heater temperature and the heat transfer coefficient are obtained for stepwise increase and decrease of heat input. Variation of the heater temperature is obtained with the quasi-static assumption. The quasi-static assumption is valid if the wall heat capacity is large compared to that of the effective thermal boundary layer in fluid. Some applications to a pulse reactor are discussed. The quasi-static assumption results in a higher fuel surface temperature during pulse heating if a gap is filled with sodium.

54596 Safety evaluation guide on the emergency core cooling systems of light water power reactors. pp 143-162 of In Laws concerning the regulations of nuclear reactors, 1976 edition. Tokyo, Japan; Taisei shuppan (1976). (In Japanese)

Issued by the Japan AEC, the safety evaluation guide is for evaluation of the functions and performance in design of the emergency core cooling systems (ECCS) of light water power reactors. ECCS are intended to suppress release of the FPs out of the Zircalloy claddings of the UO_2, plus small amount of plutonium oxide, pellets at the time of hypothetical LOCAs. Requirements of the ECCS in this case are then the maximum cladding temperature below 1200°C, the oxidized cladding thickness of less than 15%, the oxygen quantity due to cladding-water reaction of below integrity level of the reactor containment vessel, and decay heat removal of long-lived radionuclides. The guide is given broadly in three major phases of blowdown, reflooding, and heat-up.

54597 Guidelines concerning the demands to be made on safety specifications for nuclear power plants. *Gemeinsames Ministerialbl., A;* No. 15, 199-200(1976). (In German).

The Laenderausschuss fuer Atomenergie has decided on March 18th, 1976 to have all data, limiting values, and measures important for the safe condition and operation of nuclear power plants compiled in one document, the safety specifications. This is to improve a complete and quick survey of the nuclear power plants, important properties concerning safety, and to facilitate their safe operation. The presentation of safety specifications of this kind by the applicant is to be a precondition for the granting of a licence for the operation of nuclear power plants, and to be part of the licence. The requirements which have to be met by safety specifications are compiled in a list of memos (annex)..

54598 Safety design criteria and operating experience. Herbst, J.J.; Hubbard, F.R. III. (Combustion Engineering, Inc., Hartford, CT). pp 440-446 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

It has been shown that a quantitative definition of a probability and criteria categorization matrix can be developed within the present nuclear regulatory requirements. It is time that actual plant operating experience and the application of existing methodology be factored into the regulatory process. Such a formal and consistent approach for matching criteria with event probabilities in an equal risk per event approach suggests a rational limit to the NRC licensing escalation process. The conservatism of the nuclear reactor design process is amply demonstrated in that only three of the abnormal occurrences considered in the design process have actually occurred with a frequency greater than once per reactor year. Some of the incidents have never occurred in the history of commercial PWR plants, which to date encompasses over 120 reactor years of operation. One of these, the total loss of coolant flow with electric power available, has nevertheless been a postulated incident which has limited plant operation. It is a tribute to nuclear power plant designers and operators that actual plant operation has never resulted in an incident which has violated the restrictive traditional radiological release criteria. The categorizations based on operating data reflects only the frequency of occurrence of the event itself and does not include the low probability conservative assumptions in the Standard Review Plans analysis requirements. The operating history of nuclear power plants, however, does not provide sufficient data to classify low probability incidents, namely those that have not yet occurred and those which probably never will occur. Guidance to their classification can be obtained from the data and methodology of the Reactor Safety Study, WASH 1400.

54599 Response to recent criticisms concerning reactor safety. Cahill, W.J. Jr. (Consolidated Edison Co. of New York, Inc.). pp 447-451 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

In spite of the successful and safe operation of over 50 U.S. licensed reactors for 20 years, questions of reactor safety still remain and have been augmented by new worries: That civil use of nuclear power will lead to nuclear weapon proliferation and even that nuclear power is not an economic alternative (often caused by delays and uncertainties attributable to opponents of nuclear power and the very large resulting increase in capital costs). Other issues such as safety of reactor design, standardization, and storage of nuclear wastes are considered briefly. Finally, it is concluded that the provision of an abundance of energy by nuclear methods is more likely to lead to peace by alleviating economic scarcities which might lead to war. Also the hope of preventing the spread of nuclear weapons by frustrating the peaceful application of nuclear power is regarded as unrealistic. In addition, it should be recognized that terrorists have effective and simpler means for disrupting society. (LTN)

54600 Nuclear reactor safety. Levine, S. (U.S. Nuclear Regulatory Commission, Washington, DC). pp 466-477 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

Although the extensive nuclear safety program has resulted in a well-developed set of safety requirements for the plants, nuclear safety has lately attracted public attention because of the large number of plants (about 235) in various stages of operation, construction, and planning. The reason for not accepting the safety record as being completely reassuring is that it is possible to hypothesize accidents in reactors whose potential for damage to public health and property can be significant. However, the question of how large the risks can be is the subject of considerable discussion. Since there have been no accidents causing dangerous releases of radioactivity from commercial nuclear power plants, it is necessary to examine the potential risks from events which can be imagined, but which have not yet happened--that is, those having a relatively low frequency of occurrence. Thus, estimates of risks from potential accidents must involve predictive techniques for the probability of such accidents and of their consequences. To provide such estimates, the Atomic Energy Commission in the summer of 1972 started a reactor safety study under the direction of N.C. Rasmussen of the Massachusetts Institute of Technology. A draft reactor safety study report, An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, WASH-1400 was circulated in August 1974 for public comment. Comments received from some 90 organizations and representing a wide diversity of viewpoints and expertise were analyzed, and a report of the same name was published in October 1975 (by the U.S. Nuclear Regulatory Commission, superseding the AEC). The material presented is an overview of the reactor safety study report and contains some indication of the effects of the principal comments.

54601 Vertical temperature distributions in LOCA analysis. Carbajo, R. College Park, MD; Univ. of Maryland (1976). 158p. University Microfilms Order No. 77-9494.

Thesis (Ph. D.).

A new space and time dependent containment pressure and temperature analysis Code (TECAR) has been developed. The new Code, which is presently valid only for full pressure containment systems, has all the features of the present Codes used by industry and, in addition, calculates the temperature in the containment as a function of height (temperature-space dependence). The Code has been verified against the experimental data available. It appears to describe the Carolinas-Virginia Tube Reactor Experiments quite well. Other experimental data has also been verified.

54602 Progress of studies on the loss of coolant accident in LWPR in Japan. Centering around ROSA project. Shiba, M. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Genshiryoku Kogyo;* **22**: No. 6, 25-29(Jun 1976). (In Japanese).

The researches relating to LOCA in Japan are reviewed. The first part gives SAFE project as prologue. The second part describes the experiment made by the Electrotechnical Laboratory prior to ROSA project. The third part illustrated ROSA-I project with a large scale test plant. The fourth part describes the activity of the code arranged committee. The fifth part illustrates ROSA-II project as ECCS experiment with a larger scale test plant. The apparatus comprises a 300 liter pressure vessel of maximum servicing pressure of 165 kg/cm² abs and 325 deg C, and two loops, one of which is a large one and the other a small one each having a circulating pump and a steam generator, respectively.

54603 European (Economic) community and nuclear safety. *Combustion;* **47**: No. 12, 32-39(Jun 1976).

World-wide energy resources and demands are described. A nuclear action plan for Europe designed to include strict measures to protect both public health and the environment is presented. Community radiation protection standards, environmental effects (thermal discharge, radioactive wastes, and the decommissioning of nuclear power stations), nuclear plant safety (coordinating standards and techniques in member states and research on potential accidents), problems in transporting radioactive materials, and supervision of the use of fissile materials are discussed.

54604 Computer programmes of the Power Research Institute for the analysis of processes in the primary coolant circuit and in the containment of a WWER plant in a loss-of-coolant accident. Misak, J. *Jad. Energ.;* **22**: No. 8, 306-310(Aug 1976). (In Slovak).

A brief description is given of computer programmes for the analysis of loss-of-coolant accidents (LOCA) in WWER type reactors. The LENKA programme is intended for the thermal and

hydraulic analysis of the consequences of such accidents in the primary coolant circuit. The SICHTA programme is intended for the detailed calculation of the time dependence of the axial and radial distribution of heat in fuel rods from steady-state to the flooding of the core. CHEMLOC is intended for the analysis of the heat history of the core and the extent of chemical reactions in LOCA when the emergency core cooling system is not operating. The TRACO I is intended for the analysis of the initial stage of the transient process in a full-pressure containment after LOCA (the computation of the time and spatial dependences of pressures and temperatures). TRACO III is intended for the computation of the long-term time dependence of pressure and temperature in the full-pressure containment after LOCA.

54605 Prediction of the CRBRP outlet plenum transient response following a reactor trip. Novendstern, E.H.; Reese, J.C.; Budden, M.J. New York; American Society of Mechanical Engineers (1977). 8p. (CONF-770802—5). .

From National heat transfer conference; Atlantic City, New Jersey, United States of America (USA) (15 Aug 1977).

An assessment was made of the ability of a numerical hydro computer code, VARR-II, to accurately predict the transient response of the outlet plenum of the Clinch River Breeder Reactor Plant, following a reactor trip. Analytical model size and representation of the internals, located in the outlet plenum, were varied and a model to represent the outlet plenum was selected. Using this analytical model, the calculated temperature response compared favorably with experimental data, which included the effects of flow stratification following a simulated reactor trip.

54606 Dinosaurus hunters meet. Goedkoop, J.A. (Stichting Energieonderzoek Centrum Nederland, Petten). *Energiespectrum;* **1**: No. 1, 9-16(Jan 1977). (In Dutch).

Supersedes Atoomenergie en haar toepassingen.

This article deals with the Hypothetical Core Disruptive Accident (HCDA) as discussed at the Chicago Conference on Fast Reactor Safety and Related Physics. The author concludes that concensus was reached on the relation between the supposed increase in reactivity, dk/dt (t=0), and fission-heat production, while one person did not agree upon the boundary values of dk/dt (t=0) and the consequences of a HCDA. A discussion of both aspects, with emphasis on ECN-contributions to the conference, is presented.

54607 Safety requirements for nuclear power plants. Pt. 10. In-service inspections. Haehnel, G. (Kerntechnischer Ausschuss (KTA), Koeln (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 2, ang p. 2, 4(Feb 1977). (In German).

A compilation is presented of test methods which have to be carried out during the whole lifetime of the plant at certain intervals to prove the technical integrity of the components: visual tests, surface tests, volumetric tests, pressure testing.

54608 Independence, expertise and nuclear power. Mackintosh, A.R. (Copenhagen Univ. (Denmark)). *Phys. Bull. (London);* **28**: No. 4, 165-166(Apr 1977).

Comment is made on the report on Nuclear Power and the Environment by the Royal Commission on Environmental Pollution. Accepting the Commission's evaluation that the genetic effects at the levels of radiation likely to be permitted should be of little concern, that no case has been made on the special carcinogenicity of 'hot' plutonium particles and that the risk of serious accidents in any single reactor is extremely small, attention is here focused on the problems of the management of radioactive waste (long-lived isotopes and the concentration of actinides), the potentialities for terrorism in connection with nuclear power and the future of the breeder reactor. The author feels that the scientific community could make a much greater contribution to a rational discussion of the energy problem.

54609 Thermal interaction of molten LWR core materials with water. Nelson, L.S.; Buxton, L.D. (Sandia Labs., Albuquerque). *Trans. Am. Nucl. Soc.;* **26**: 397-398(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54610 Impulse-initiated gas release: a possible trigger for vapor explosions. Buxton, L.D.; Nelson, L.S. (Sandia Labs., Albuquerque). *Trans. Am. Nucl. Soc.;* **26**: 398-399(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54611 Response of concrete to high heat fluxes. Muir, J.F. (Sandia Labs., Albuquerque). *Trans. Am. Nucl. Soc.;* **26**: 399-400(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54612 Empirical models for the thermal decomposition of concrete. Powers, D.A. (Sandia Labs., Albuquerque). *Trans. Am. Nucl. Soc.;* **26**: 400(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54613 Large-scale melt/concrete interactions tests. Powers, D.A. (Sandia Labs., Albuquerque). *Trans. Am. Nucl. Soc.;* **26**: 400-401(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54614 Heat and mass transfer behind a heated reactor cell liner. Dayan, A.; Gluekler, E.L. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.;* **26**: 401-402(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54615 Risk criteria and standards: should they be related. Brunot, W.K. (Pacific Gas and Electric Co., San Francisco). *Trans. Am. Nucl. Soc.;* **26**: 403(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54616 Probability of violating safety standards due to ATWS occurrences. Stevens, C.A. (Science Applications, Inc., Palo Alto, CA). *Trans. Am. Nucl. Soc.;* **26**: 403(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54617 Comments of conservatism in the selection of seismic design parameters for nuclear reactor structures and equipment. Newmark, N.M.; Hall, W.J. (Univ. of Illinois, Urbana). *Trans. Am. Nucl. Soc.;* **26**: 403-404(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54618 Relative rupture probabilities at various locations in reactor coolant piping. Harris, D.O. (Science Applications, Inc., Palo Alto, CA). *Trans. Am. Nucl. Soc.;* **26**: 404(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54619 Use of probabilistic methods for risk assessment and for safety standard. Apostolakis, G.E.; Okrent, D. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **26**: 404-405(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54620 Investigation of alternative ECC injection concepts in the semiscale MOD-1 system. Peterson, A.C.; Harvego, E.A.; North, P. (EG and G Idaho, Inc., Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* **26**: 406-407(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54621 ROSA-II UHI tests in JAERI. Tasaka, K.; Shiba, M.; Adachi, H.; Okazaki, M.; Suzuki, M.; Soda, K.; Sobajima, M. (Japan Atomic Energy Research Inst., Tokai, Ibaraki). *Trans. Am. Nucl. Soc.;* **26**: 407-408(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54622 ECC penetration studies investigating alternative injection configurations. Cudnik, R.A.; Flanigan, L.J.; Denning, R.S. (Battelle Columbus Labs., OH). *Trans. Am. Nucl. Soc.;* **26**: 408(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54623 Efficiency of combined cold- and hot-leg injection. Mayinger, F. (Tech. Univ. of Hanover); Winkler, F.; Hein, D. *Trans. Am. Nucl. Soc.;* **26**: 408-409(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54624 Westinghouse Upper Head Injection system and typical results. Young, M.Y.; McIntyre, B.A.; Docherty, P.J. (Westinghouse

Electric Corp., Pittsburgh). *Trans. Am. Nucl. Soc.;* 26: 409-410(Jun 1977).

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54625 Evaluation of ECCS for PWRs. Block, J.A.; Stacy, W.D.; Crowley, C.J. (Creare Inc., Hanover, NH). *Trans. Am. Nucl. Soc.;* 26: 410-412(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54626 Thermomechanical loading of an adjacent hexcan. Kennedy, J.M.; Kulak, R.F. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* 26: 454-455(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54627 Comparison of an analytical model with containment blowdown experiments. Filacchione, H.; Thiesing, J.W. (Bechtel Power Corp., Gaithersburg, MD). *Trans. Am. Nucl. Soc.;* 26: 469-471(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54628 Condensing heat transfer following a LOCA. Krotiuk, W.J.; Rubin, M.B. (Ebasco Services Inc., New York). *Trans. Am. Nucl. Soc.;* 26: 471-472(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54629 Impact of small pipe weld types on personnel exposure. Carlton, R.E.; Walt, T.D. (Bechtel Power Corp., San Francisco). *Trans. Am. Nucl. Soc.;* 26: 489(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54630 Effect of operator performance on reactor shutdown system (RSS) reliability. Husseiny, A.A. (Iowa State Univ., Ames); Sabri, Z.A.; Danofsky, R.A.; Joos, D.W. *Trans. Am. Nucl. Soc.;* 26: 519-520(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54631 Evaluation of full-core steam flooding worth in simulated GCFR configurations. Hess, A.L.; Rucker, R.A. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* 26: 532(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54632 Impact of accidental steam entry on GCFR physics parameters. Bhattacharyya, S.K.; Morman, J.A.; Bucher, R.G.; Robinson, W.R.; Smith, D.M. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* 26: 532-533(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54633 Modified diffusion theory analysis of simulated meltdown experiments. Seki, Y.; Sasaki, M. (Mitsubishi Atomic Power Industries, Inc., Saitama, Japan). *Trans. Am. Nucl. Soc.;* 26: 535-536(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54634 Resources available at the Nuclear Safety Information Center. Cottrell, W.B. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* 26: 567-568(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

ACCIDENT LIABILITY

54635 Act No. 109 of 12 February 1974 ratifying and bringing into force the Conventions on third party liability in the field of nuclear energy signed in Paris on 29 July 1960 and in Brussels on 31 January 1963 as well as the Additional Protocols thereto signed in Paris on 28 January 1964. *Geburtshilfe Frauenheilkd.;* 115: No. , 9) p. 2962(27 Apr 1974). (In Italian).

This Act authorizes the Italian authorities to ratify the Convention on Third Party Liability in the Field of Nuclear Energy signed in Paris on 29th July 1960 and the Supplementary Convention thereto signed in Brussels on 31st January 1963, as well as the Additional Protocols to both Conventions signed in Paris on 28th January 1964. The Italian texts of the Conventions are reproduced after the Act. Furthermore, the Government is vested with the powers required to lay down by Decree, within a year of the entry into force of the Act, the measures to implement and to co-ordinate these Conventions with domestic law. Finally, the Act confirms the executive authority of the decisions taken by the European Nuclear Energy Tribunal.

54636 Decree No. 519 of 10 May 1975 of the President of the Republic on regulations implementing international instruments in the field of nuclear third party liability ratified and brought into force by Act No. 109 of 12 February 1974 and for co-ordination of the above-instruments with the provisions of laws in force. *Geburtshilfe Frauenheilkd.;* 116: No. , 9) p. 7859-7862(6 Nov 1975). (In Italian).

This Decree was made by the President of the Republic under a delegation of powers conferred by Act No. 109 of 12th February 1974 ratifying the Paris Convention and the Brussels Supplementary Convention on nuclear third party liability. Its purpose is to make provision for implementing these Conventions in domestic law and to amend national legislation accordingly, i.e. Act No. 1860 of 31st December 1962 on Peaceful Uses of Nuclear Energy. The provisions so amended are Section 1 (definitions) and Sections 15 to 24 (third party liability following from the peaceful uses of nuclear energy). In particular, the maximum amount of liability of the operator of a nuclear installations is set at 7,500 million lire; beyond this amount the ceiling of compensation which may be granted by the State's financial intervention is 43,750 million lire. In cases where damage exceeds this ceiling it will be compensated up to 75,000 million lire by a contribution from other countries Party to the above-mentioned Conventions. The Decreee came into force on 6th November 1975.

ENERGY STORAGE

THERMAL

54637 Storage block for electrical storage radiator. Muckenfuss, K. (to Malag-Werke Adolf Muckenfuss und Soehne, Bretten (Germany, F.R.)). German(FRG) Patent 1,579,714/B/. 8 Jul 1976. 5p. (In German).

The invention concerns a storage block for an electrical storage radiator with vertical air channels. There are longitudinal and transverse grooves at the top for a heating winding or a U-shaped heating element. The storage block is made of two equal part blocks, one of whose vertical surfaces forms an even surface and whose other vertical surface is provided with two channels which project over the height of the block. These channels of the two part blocks are turned towards one another to form air channels.

54638 Method of heat storage. Bruns, P.H. (to Steinkohlen-Elektrizitaet A.G. (STEAG), Essen (Germany, F.R.)). German(FRG) Patent 2,527,119/A/. 30 Dec 1976. 9p. (In German).

The patent specification claims a super-regional network of connections of go-and-return pipelines for water, into which energy producing plants can feed waste heat and/or excess heat energy for storage, and from which consumers can take useful heat energy via heat exchangers.

54639 Overview of the ERDA thermal energy storage program. Swet, C.J. (Energy Research and Development Administration, Washington, DC). *Trans. Am. Nucl. Soc.;* 26: 413(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54640 ERDA program on thermal energy storage at temperatures below 250°C. Hoffman, H.W. (Oak Ridge National Lab., TN); Kedl, R.J.; Swet, C.J. *Trans. Am. Nucl. Soc.;* 26: 413-414(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54641 High-temperature thermal energy storage. Joyce, J.P. (Lewis Research Center, Cleveland). *Trans. Am. Nucl. Soc.;* 26: 414-415(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

54642 Thermochemical energy storage and transport program. Mar, R.W.; Bramlette, T.T. (Sandia Labs., Albuquerque). *Trans. Am. Nucl. Soc.;* 26: 415-416(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

CHEMICAL

REFER ALSO TO CITATION(S) 54642

BATTERIES

PERFORMANCE AND TESTING

54643 (AD-A—038915) **Detection of elementary processes within porous electrodes. Interim report.** Szpak, S.; Katan, T. (Lockheed Missiles and Space Co., Palo Alto, Calif. (USA). Lockheed Palo Alto Research Lab.). 18 Apr 1977. Contract N00014-73-C-0397. 16p. NTIS PCA02/MF A01.

The interaction of elementary processes within the confines of porous structures is simplified by application of concepts such as penetration depth and a structural unit characteristic of porous electrodes. A systematic approach to the determination of relevant processes and specification of electrode structure is presented. Both experimental and mathematical analogs are used.

MATERIALS, COMPONENTS, AND AUXILIARIES

54644 (AD-A—038754) **Development of an improved separator material for alkaline silver—zinc batteries. Preliminary study Dec 75—May 76.** Kilroy, W.P.; Duffy, J.V. (Naval Surface Weapons Center, Silver Spring, Md. (USA)). 1 Feb 1977. 27p. (NSWC/WOL/TR—76-135). NTIS PCA03/MF A01.

This work was a preliminary investigation to determine if polyphenylquinoxaline (PPQ) or a codispersed mixture of polyvinylpyrrolidone (PVP) with PPQ could be used to replace cellophane as a separator in the zinc—silver oxide battery. The primary purpose was to compare its dimensional and chemical stability with cellophane and to determine if methods could be developed to lower its high inherent electrical resistance. Dimensional measurements were made in 45% KOH at 298 K (25 C) and 353 K (80 C). Chemical stability to oxidation was observed in KOH solution saturated with silver oxide at 353 K. In an effort to lower the resistance of these thin film membranes, various methods were studied to develop porosity. Included among these were extraction of the PVP in boiling water, pyrolysis of the PVP, swelling of the films with phenol, and precipitation of the PPQ from acetone. Increasing the molecular weight of the PVP appears very promising, and additional studies are recommended since these polymers have good potential use as separators.

54645 **Improved thermal battery.** Bush, D.M. (to Energy Research and Development Administration, Washington, D.C. (USA)). German(FRG) Patent 2,524,037/A/. 18 Dec 1975. 11p. (In German).

The patent specification claims the chemical composition of fusible solid electrolyte plates of thermal batteries which contain calcium anodes and heat generating plates. The homogeneous mixture of the electrolyte plates consists of calcium chromate depolarizer, a silicon diode binder and a mixture of calcium chloride, lithium chloride and calcium hydroxide.

54646 **Investigation of the surface structure of some lead dioxide and related electrodes.** Casson, P. (Univ. of Loughborough, Eng.); Hampson, N.A.; Peters, K.; Whyatt, P. *J. Appl. Electrochem.;* 7: No. 3, 257-265(May 1977).

S.E.M. observations were carried out on PbO_2 and related electrodes after electrochemical reaction in 5 M H_2SO_4. The morphology of the surfaces examined is strongly affected by their history, particularly their charge/discharge cycles. $PbSO_4$ formed by the self-corrosion process is much more porous than that formed by the electrochemical reduction of PbO_2. 13 figs.

54647 **Point of passivation of a zinc electrode in alkali.** Marhall, A. (Ciba-Geigy Ltd., Simonsway, Eng.); Hampson, N.A. *J. Appl. Electrochem.;* 7: No. 3, 271-273(May 1977).

Confirmatory evidence is provided that at the point of passivation of solid zinc in alkali there is no free OH^- in the reaction layer at the electrode. 2 figs.

ENERGY MANAGEMENT AND POLICY

54648 (AD-A—038802) **Energy fact book, 1977. Technical report.** (Tetra Tech, Inc., Arlington, Va. (USA)). Apr 1977. Contract N00014-76-C-0239. 446p. (TETRAT-A—642-77-306). NTIS PCA19/MF A01.

Supersedes Rept. No. TETRAT-A-642-76-254 dated 15 Jul 76, AD-A—028284 and report dated 1975, AD-A—029331.

The Energy Fact Book, 1977 summarizes the present U.S. Energy situation; Energy R and D Legislation; Federal Government Energy R and D; and International Energy R and D. It includes a brief description of the various processes and developments related to hydrocarbon fuels, synthetic fuels, non-hydrocarbon energy sources and energy conservation. (GRA)

54649 (SAND—77-0921) **Sandia energy titles.** Gardner, J.L. (ed.). (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 54p. Dep. NTIS, PC A04/MF A01.

This bibliography of reports, periodical arricles, and conference papers represents research carried out by Sandia Laboratories in energy and conservation. Within each of the approximately 300 entries, authors are listed alphabetically in each subject category. The following subjects are covered: Conservation, drilling technology, environment and safety, fossil energy, geothermal energy, nuclear energy, and solar energy. (MCW)

54650 **Third annual energy report, 1977.** Des Moines; Iowa Energy Policy Council (1977). 73p. (NP—22088).

A compilation of energy data for the state of Iowa is published for use in considering energy matters. Included are information about the historic use and distribution of energy in Iowa, the growth rate of energy consumption in Iowa, a projection of energy consumption trends in Iowa for the next ten years, assessments of the impact of meeting those needs on the economy and the environment of the state, evaluations of alternative sources of energy, and of the feasibility of coal gasification. A statement of the Council's energy conservation policy, together with a plan to carry out that policy, is a part of this report. There also are subjects suggested for legislation which, in the Council members' judgment, would help bring about this energy conservation plan.

SYSTEMS STUDIES AND TOTAL ENERGY

REFER ALSO TO CITATION(S) 54703

54651 (FE—2443-2) **Using net energy methodology for energy planning: tradeoffs of supply vs. end-use technologies. Volume II. Final report.** (Development Sciences, Inc., East Sandwich, Mass. (USA)). 15 Apr 1977. Contract EX-76-C-01-2443. 329p. Dep. NTIS, PC A14/MF A01.

This volume contains Chapters 3, 4, and 5 of the study. Chapter 3 contains an overview of methodology. An attempt is made to present a concise review of the basics of net energy analysis developed previously and to demonstrate how an analysis can be structured to be easily reproducible. The data and characteristics are those of New England, concerned specifically with New England space and water heating, also discussed in the chapter are energy supply trajectories and energy supply-demand options. Information contained in Chapter 4 provides the basis for the results and conclusions reported in Chapter 2. The chapter is divided into four parts: Section 4.1, an outline of the options for New England space and water heating; Section 4.2, the trajectories used to represent energy supply systems; Section 4.3, descriptions of the supply modules from which trajectories in Section 4.2 were built; and Section 4.4, the modules that determine energy demand for space and water heating. Chapter 5 consists of the following appendices: New England Energy Balance; New England Building Mix and Projected New Construction; Residential Buildings in New England; Commercial Buildings; Sample Module Calculation (Module 4.3.25, Coal Liquefaction by Catalytic Hydrogenation); Nuclear-Electric Power; Comparison of Transportation Modes; and Conversion Factors. (MCW)

54652 (PB—265895) **A public utility rate case intervention strategy for the city of Durham, North Carolina. Final report.** Magat, W.A. (Durham Urban Observatory, N.C. (USA)). Sep 1976. 89p. (UO-LCCM-DUR—76-004). NTIS, PC A05/MF A01.

Prepared in cooperation with National League of Cities/U.S. Conference of Mayors, Washington, D.C., Contract HUD-H-2196R.

This study examines the role that the city of Durham, North Carolina should take concerning rate cases of the telephone, electric, gas, and transit utilities serving the Durham community. After examining the various arguments that the City could pursue when intervening in general rate cases, it is recommended that Durham intervene in all rate cases involving the four utilities which serve the area. The study identifies those arguments (pertaining to areas such as cost of capital, rate structure, and quality of service) which should be made in each case and suggests strategies for presenting those arguments. Some other suggestions are offered concerning coordinating Durham's intervention activities with those of the Attorney General and those of other municipalities. Since transit regulation

takes a different form from that of electric, telephone, and gas utility regulation, intervention in transit cases is considered separately.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 53716, 54651, 54664, 54667, 54668, 54681, 54694, 54695, 54696, 54702, 54706, 54707

54653 (PB—265755) **FEA energy facility siting workshops.** (Federal Energy Administration, Washington, D.C. (USA)). Jan 1977. 463p. (FEA/G—77/064). NTIS, PC A20/MF A01.

The administration of energy facility siting has become increasingly complex due to the enactment of various environmental legislation and the resulting socio-economic impacts. The FEA, therefore, undertook to evaluate recent legislative and administrative initiatives of both the Federal Government and the States, and to explore the public concerns which motivated these developments. The first workshop focused on financial approaches to mitigation of socio-economic impacts in the Western Interior States arising from energy resource development. The second workshop concentrated both on the siting process itself and on the optimal approaches to incorporating environmental and socio-economic considerations into that process.

54654 (PB—265804) **Federal assistance programs and energy development-impacted municipalities.** (Wendell Associates, McLean, Va. (USA)). Feb 1976. Contract FEA-CO-04-60431-00. 112p. NTIS, PC A06/MF A01.

This study identifies Federal assistance programs which do or could provide aid for small communities impacted by major energy developments. The objectives have been to identify those Federal programs which presently offer the types of aid most rquired by small communities facing sudden and rapid growth, especially those designed to build their planning and administrative capacity or infrastructure. It is also intended to analyze other programs of assistance to local governments to show why they are not presently suitable for use by these communities, and to indicate what kinds of changes would be necessary to make them useful to such communities.

54655 **Strengthening public management in the intergovernmental system.** Washington, DC; Executive Office of the President (1975). 75p. GPO $1.45.

In August 1974 the Office of Management of Budget initiated an interagency Study Committee on Policy Management Assistance comprised of Federal career executives whose agencies were interested in strengthening the core management capabilities of state and local general purpose governments. Problems addressed include resource scarcity, environmental concerns, changing values about work, and the quality of life. These do not lend themselves to simple national solutions, taking diverse forms in different regions, states, and communities. This report addresses the question of how the Federal government can assist in improving state and local government management. It was found that the principal need was to strengthen the hands of top elected officials and administrators. A three part strategy was recommended: (1) reorienting Federal domestic programs, in order to minimize the administrative burdens on state and local government and the conflicts with local priorities; (2) expanding and coordinating Federal public management assistance specifically aimed at strengthening the overall management capacity of state and local governments that desire such assistance; and (3) improving the Federal government's machinery for conducting intergovernmental business in order to bring about more effective state and local participation and liaison in accomplishing the two objectives stated above. (MCW)

54656 **Report on significant interrelationships between electric power generation and natural and developed resources in the Connecticut River Basin.** Washington, DC; Federal Power Commission (1976). vp. (NP—22085).

The report was prepared as an effort toward the eventual development of a methodology for assessing the interrelationships between hydroelectric power and natural resources in an entire river basin. The Connecticut River Basin (CRB) was chosen as the first area to study because of its long history of water power. The content of this environmental evaluation utilizes the major items prescribed by the Council on Environmental Quality for an environmental impact statement except where the scope of the report necessitates a modification of the Council's format. The five major parts and related sections of this report are Basic Considerations (description of the proposed action and the method used to study possible consequences of the actions); Existing Component Parts of the CRB (description of the electric system, including the role of hydroelectric generation; socio-economic structure within the basin; chief physical aspects of the natural environment, including existing man-made alterations; and, impacts within the existing environment); Trends in socio-economic development (an examination of those aspects of societal growth which contribute significantly to changes in the environment); Assumed future alternatives (consideration of: probable alternatives; the need for electricity; and changes in the electric system, socio-economic structure, and the natural environment); Impacts on the quality of life: the impact of the assumed alternatives upon socio-economic structure and the natural environment considering: probable environmental impacts; significant probable adverse environmental impacts which cannot be avoided; and the extent of environmental impacts with a summary of the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity combined with the irreversible and irretrievable commitment of resources. (MCW)

54657 **Alternatives for Washington. Volume VII. The cost/trade-off study team reports.** Olympia, WA; Office of Program Planning and Fiscal Management (1976). 283p. (NP—22186).

During 1974 over 60,000 citizens were involved in the Alternatives for Washington process of determining preferences for Washington's future. These preferences and the goals established during this first phase were compiled into a summary report, Pathways to Washington 1985: "A Beginning--Citizens' Recommendations for the Future" (Volume 1, Report No. 1). A second phase of the Alternatives for Washington process was undertaken during the early months of 1976 to further elaborate the programs and action items necessary to achieve the goals identified in Phase 1, and to determine the costs involved and the trade-offs or hard choices that the people will have to consider in order to preserve and enhance the future of Washington. Six Cost/Trade-Off Study Teams were formed to consider the citizens' recommendations from Phase 1 regarding economic growth, the environment, our natural and human resources, and governmental change. These teams were comprised of citizens, state agency officials, and technical experts. The results of their deliberations are the 14 individual team/committee reports contained in this volume. These team/committee reports examine current trends to determine what needs to be accomplished to achieve the citizens' goals. The teams then evaluated the proposed sets of programs and action items to determine the costs and benefits and to identify the trade-offs or hard choices involved. Another report contains a summary of the study teams' findings, Alternatives on the Pathway to 1985: "The Costs and Hard Choices" (Volume 1, Report No. 2).

54658 **Institute on Indian Land Development: oil, gas, coal, and other minerals.** Boulder, CO; Rocky Mountain Mineral Law Foundation (1976). vp. (CONF-7604134—).

From Seminar on mineral development on Indian lands; Tucson, Arizona, United States of America (USA) (1 Apr 1976).

Fifteen papers were presented at the seminar, namely: An Indian View of Minerals Development on Indian Lands, Peter MacDonald; American Indian Culture and Tradition (Northern Plains), Barney Old Coyote; Culture of the Indians of the Southwest and Southern Rocky Mountains, Dr. Emory Sekaquaptewa; Legal Status of Indians, Stephen G. Boyden and Scott C. Pugsley; Indian Land Status, William G. Lavell; Conventional Leasing for Mineral Development of Indian Land, Mark K. Adams; Title Examination of Indian Lands, Louis R. Moore; Environmental Protection of Indian Lands and Application of N.E.P.A, J. Kemper Well; Indian Control and Use of Water for Mineral Development, Glen A. Wilkinson and Jerry C. Strauss; Reemergence of Tribal Nationalism, Dan H. Israel; Industry Problems with the Emerging Tribal Role, Fred E. Ferguson, Jr.; Indian Lands Mineral Development--The Federation of Upper Missouri Tribes and Their New Data Base, Richard N. Wilson; Indian Self-Determination--New Patterns for Mineral Development, Alvin J. Ziontz; Practical Application of Cooperative Programs to the Emerging Role Concept, C. Ted Clark; and The Role of the Trustee--How Shall the Government Serve, Martin E. Seneca, Jr. A bibliography is included: law review articles on natural resources on Indian lands. (MCW)

54659 **Methodology and criteria for siting energy plants in Idaho.** Warnick, C.C. Moscow, ID; University of Idaho (1976). 80p. (NP—22102).

This study contains a review of energy plant siting criteria, methodologies, guidelines and programs that are being considered today in this country. A preliminary screening approach for siting energy plants in Idaho is presented and a detailed hierarchical classification system for siting criteria has been developed. Methodology for using the criteria is suggested. Experience of a workshop trying to identify problems of implementing a ranking and rating for siting energy plants in the general situation for Idaho is reported. A brief analysis is presented on the needs for regulations and legislation to implement a future program of evaluation that would benefit utilities, the planning agencies, and the regulatory agencies operating within the state of Idaho.

54660 **Towards an ecologically-based economic philosophy.** Hanson, J.A. (Oceanic Inst., Waimanalo, Hawaii). *Environ. Conserv.;* 4: No. 1, 3-10(Spr 1977).

The present global economic order is one which fails to recognize the finiteness of global resources and the finiteness of the global ecosystem to absorb wastes. The global economic system, as it is functioning today, exhibits little or no awareness that they are at all important to a stable world economy. Superimposed upon this condition is the "Autophage Effect", which points to a continuing acceleration in depletion of raw resources even though the net resource/demands of the world's populations may stabilize. This is a human predicament which cannot and will not continue indefinitely. The key question is, "Will Earth's societies acknowledge the situation early enough to choose alternatives." There appear to be only two fundamental alternatives: either the present level of population and material abundance (imperfect as it may be) will crash, or it will be replaced by a world economic order which attends to the finiteness of this planet. The basic structure of the new economic order may rather closely resemble the ecologists' "trophic" divisions in natural ecosystems (e.g. Lindeman, 1942). If this comes to pass, conservation of energy and order (negentropy) will very likely emerge as the prime forcing functions in the resulting world socio-economic order.

54661 Variable fuel tax models. Vecellio, R.L.; Moore, R.K. (Auburn Univ., AL). *Transp. Eng. J.;* **103**: No. TE4, 461-476(Jul 1977).

Four variable fuel tax models are investigated with respect to Alabama Highway Department operations. The Fixed Percentage Fuel Tax Model establishes the state gasoline tax as a constant percentage of the wholesale price of gasoline. The Price Index Economic Model pegs state fuel taxes to a ratio of price indexes. The Fuel Efficiency Tax Model relates the gasoline tax to the variables of Consumer Price Index and vehicle efficiency. The Sales Tax Model establishes a sales tax on the purchase of gasoline and motor fuel sold in the state. Estimates of the amount of revenue expected to be generated by each model are made. Advantages and disadvantages of each model are presented.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 53634, 54653, 54659, 54660, 54669

54662 (NP—22094) **Environmental inspection routes: an operations research analysis working paper No. 21.** Dinkel, J.U.; Kleindorfer, G.B.; Kochenberger, G.A. (Pennsylvania State Univ., University Park (USA). Center for the Study of Environmental Policy). 12 Sep 1975. 14p. State Univ., University Park, PA.

The travel cost for environmental quality inspection of plant sites is of increasing concern to budgetarily-pressed agencies. This paper describes a computerized system for designing lower cost travel tours, and for studying associated problems such as office location and regional definitions of responsibility. Examples of applications of the system to Pensylvania regional air quality planning problems are also described.

54663 (PB—265479) **Background information for an opacity standard of performance for basic oxygen process furnaces in iron and steel plants.** (Environmental Protection Agency, Research Triangle Park, N.C. (USA). Office of Air Quality Planning and Standards). Mar 1977. 66p. (EPA/450/2—77-004). NTIS, PC A04/MF A01.

The document presents the basis for the proposed opacity standard for basic oxygen process furnaces. Included is process and emission control information along with the rationale for the proposed standard. Monitoring requirements and visual test results are also included.

54664 (PB—266017) **Coastal facility guidelines: a methodology for development with environmental case studies on marinas and power plants. Working paper.** Laist, D. (National Oceanic and Atmospheric Administration, Rockville, Md. (USA). Office of Coastal Zone Management). Aug 1976. 158p. (NOAA—77030311). NTIS, PC A03/MF A01.

This report provides state coastal zone management (CZM) agencies with information and recommendations for developing guidelines for facility development in the coastal zone. Section A of the report presents a methodology for identifying and initiating implementation procedures for management recommendations on specific facility types. Sections B and C apply the methodology to marinas and power plants in the states of Florida and Maryland, respectively. The two case studies from Florida and Maryland serve the dual purpose of (1) providing a useful CZM reference source on environmental mitigation techniques and relevant Federal authorities for the two facility types and (2) further clarifying the format, intended information content, and applications envisioned in the methodology.

54665 Federal, State, and local relations in the environmental area: a test of the new federalism. Fidell, E.R. (LeBoeuf, Lamb, Leiby, and MacRae, Washington, DC). pp 533-537 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

Various problems in the cooperation of Federal, state and local governments on environmental impacts are discussed. Cooperation between these governments is necessary, but a certain amount of flexibility is also necessary to reconcile the differing interests. Examples are given where problems have arisen or might arise. (LTN)

54666 Environmental inspection routes and the constrained travelling salesman problem. Dinkel, J.J.; Kleindorfer, G.B.; Kochenberger, G.A.; Wong, S.N. University Park, PA; Pennsylvania State University (1976). 37p. (NP—22100).

The constrained version of the classical traveling salesman problem (TSP) is seen to be a generic model for a wide variety of problems. Concern here is limited to problems that impinge directly on the environmental issues; however, the constrained problem is of even more general interest though not pursued here. Some potential applications are in the areas of resource management, energy conservation, and transportation. The version of the problem can be stated as: given 1 or more persons (or vehicles) that must visit a set of n sites (plants, bus stops, etc.) how can one develop a route of minimum mileage that meets certain restrictions (8-hour work day, bus seating capacity, etc.) This paper addresses the following issues in light of this problem: (1) areas of potential application--for example, locational problems (office location), regionalization studies (development of efficient regional boundaries, efficient inspection and delivery routes, long-range and short-term resource management); (2) data problems--in particular, efficient means of gathering and maintaining data; (3) numerical results: the study of efficient algorithms so that the model can be used efficiently on large problems and also on a day-to-day basis; and (4) decision-making applications in terms of analysis of operations, planning, and analysis of resources via sensitivity analysis.

ENERGY RESOURCES

REFER ALSO TO CITATION(S) 54657, 54658, 54660, 54681

54667 Future resources and world development. Rogers, P. (ed.). New York; Plenum Press (1976). 280p.

The aim of this book is to examine some of the longer-term implications of the use of global resources on prospects for world development and on relations between the developed and less-developed countries of the world. Part I consists of papers prepared especially for this volume. It begins with a contribution from Anthony Vam on "The Global Ecosystem and Human Activity" which gives an ecological perspective to trends in energy and mineral resource utilization. This is followed by a detailed case study of the one dominating example of producer power, oil; this is entitled "Oil Prices, OPEC and the Poor Oil Consuming Countries" and is by Dr. Biplab Dasgupta. Following this, Paul Rogers contributes a paper on "The Role of Less-Developed Countries in World Resource Use" which includes a consideration of the potential development of producer power for a number of primary commodities. This is followed by a paper by Dr. E. E. Banks entitled "Problems of Mineral Supply" which concentrates attention on two important minerals, copper and aluminum. Robert Dickson and Paul Rogers then contribute a discussion on the possible effects of producer power on relations between developed and less-developed countries. The editors then conclude with a summary of the views expressed in the preceding papers placed in the context of recent developments on the international scene. Part II of this book consists of a number of important documents, statements, and speeches that appeared over the period September 1973 to May 1975. This was the crucial period for the development of producer power and the contributions help to show exactly how the process has developed.

54668 Turnpike properties for the optimal use of a natural resource. Haurie, A. (Ecole des Hautes Etudes Commerciales, Montreal); Hung, N.M. *Rev. Econ. Stud.;* **44**: No. 137, 329-336(Jun 1977).

This paper is an attempt to deal rigorously with some fundamental mathematical problems arising from the consideration of natural resources in the neoclassical framework of optimal economic growth. The theory of optimal economic growth has benefited considerably from an optimal control formulation. It posed two interesting problems that seem to be typical of these economic models. The first one concerns the precise formulation of the Turnpike Property and the second one is the definition and the characterization of the optimality when the time interval considered is infinite and the formulation of existence conditions for such an optimal solution. It appeared that the two problems are linked together through the important role played in both problems by an optimal

steady state suitably defined for discrete time growth models and for continuous time control systems. In the case of optimal exploitation of a natural resource, the Turnpike Property is well illustrated by the very simple model of optimal fish-harvesting studied by Cliff and Vincent. An extension of the turnpike property to the case of an optimal growth model where both capital and natural resources enter into the production process is proven in this paper. In a final section, the cases of inexhaustible resources and non-replenishable resources are considered in the model. 23 refs. (MCW)

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 54069, 54269, 54286, 54418, 54425, 54690, 54704, 55110

54669 (PB—265318) **A guide to information resources for nuclear environmental reporting. Directory report, 1973-76.** D'Angelo, L.J. (Atomic Industrial Forum, Washington, D.C. (USA)). Feb 1977. 167p. NTIS, PC A12/MF E12.

A directory is presented of existing information resources, products and services which are relevant to the environmental information reporting requirements of Federal and state regulatory agencies and to the environmental decision-making process for energy facilities. The guide covers industrial, association, and government resources and includes descriptions of technical abstracting/indexing services and other publications, computer data banks, response and referral centers, and information supermarkets. A selective listing of data bases which may be of value in the environmental reporting process for nuclear and fossil facilities with pertinent descriptive data about each is included. The guide also lists criteria to use when requesting searches and descriptions of the various products offered by the information services covered. A glossary of terminology used by the information industry is also provided.

54670 (PB—265793) **Administration of the Radiation Control for Health and Safety Act of 1968. Public Law 90-602 (1976 annual report).** (Bureau of Radiological Health, Rockville, Md. (USA)). 1 Apr 1977. 95p. (FDA/BRH—77/77). NTIS, PC A05/MF A01.

See also report dated 1 Apr 76, PB-253 670.

The Secretary of Health, Education, and Welfare is required by Subpart 3, Part F of Title III of the Public Health Service Act; 42 USC 263b et seq. (Public Law 90-602) to submit an annual report to the President for transmittal to the Congress on or before April 1 on the administration of the Radiation Control for Health and Safety Act. The detailed information required to be included in the report is outlined in Section 360D of the Public Health Service Act. The Food and Drug Administration, through its Bureau of Radiological Health, has been delegated the authority for the day-to-day administration of the Act. This report covers the detailed operation of the Agency in carrying out that responsibility for calendar year 1976.

54671 **Cross of plutonium.** Johnson, B. *New Sci.;* 74: No. 1049, 189-190(28 Apr 1977).

The present position concerning nuclear proliferation safeguards is discussed with especial reference to the recent statement of Mr. Carter, President of the USA, outlining his country's new anti-reprocessing and anti-breeder policies. The weaknesses of the Nuclear Non-Proliferation Treaty are considered. The giving of substantial non-nuclear energy aid to developing countries is thought not to be too high a price to pay to shed the ever increasing risks associated with a plutonium economy and the worldwide accumulation of radioactive wastes.

54672 **Advanced Gas-cooled Reactor: a case study in reactor choice.** Rush, H.J.; MacKerron, G.; Surrey, J. (Univ. of Sussex, Brighton, Eng.). *Energy Policy;* 5: No. 2, 95-105(Jun 1977).

High costs and extremely long and expensive R and D programs have led to extensive involvement by governments in decisions concerning nuclear reactors. The authors examine the decision-making processes of the British nuclear industry, looking in particular at the history of the Advanced Gas-cooled Reactor (AGR). They conclude that both the institutional framework in which the decision was made and the decision itself give cause for concern. In particular, the lack of public discussion and the dual role of the UKAEA as both prototype developer and technical adviser to the government make objective judgment difficult.

54673 **Optimal timing of the US breeder.** Richels, R.G.; Plummer, J.L. (Electric Power Research Inst., Palo Alto, CA). *Energy Policy;* 5: No. 2, 106-121(Jun 1977).

Optimal timing of the introduction of the FBR is very sensitive to factors such as the availability of low-cost uranium, future energy demands, and the possibility of the introduction of yet more advanced technology. To a lesser extent it is also sensitive to the relative capital costs of fast breeder and thermal nuclear plants. The relationship between R and D costs and the program timing is also crucial in deciding optimization.

54674 **Future uranium supply and demand: industrial and commercial considerations.** Kostuik, J. (Uranium Inst., Haymarket, London). *Energy Policy;* 5: No. 2, 122-129(Jun 1977).

From International conference on nuclear power and its fuel cycle; Salzburg, Austria (2—13 May 1977).

The future growth of nuclear power is dependent on an assured supply of uranium at reasonable prices; but uranium producers, when making their own plans, are uncomfortably aware of major uncertainties in future projections of demand from electrical utilities. Having examined these uncertainties, and also those connected with uranium exploration and production, the author concludes that uranium supply is not likely to hold up the development of nuclear power, at least over the next quarter of a century.

CONSERVATION

REFER ALSO TO CITATION(S) 53639, 54648, 54650, 54666, 54684, 54710

54675 (PB—265490) **Quarterly report to U.S. House and Senate Committees on Appropriations (3rd). Quarterly report Jun-Sep 76.** (Federal Energy Administration, Washington, D.C. (USA)). Jan 1977. 40p. (FEA/D—77/027). NTIS, PC A03/MF A01.

See also 2nd quarterly rept., PB-263 418.

This is the third in a series of quarterly reports to the House and Senate Committees on Appropriations describing the process of the Federal Energy Administration's (FEA) energy conservation programs and short- and long-term accomplishments.

54676 (PB—265497) **Illinois energy conservation implementation plan. Public Hearings Abstract, conducted on January 14-February 4, 1976. Final report.** Rubenstein, B.L. (Illinois Dept. of Business and Economic Development, Springfield (USA). Div. of Energy). Feb 1977. 316p. (ILLDOE—77/01). NTIS, PC A14/MF A01.

This report presents a summary of the testimony given by 211 participants in statewide hearings. The hearings were held to receive citizen response to the Feasibility Report published by the Illinois Division of Energy and to acquire citizen input in the preparation of an Illinois energy conservation plan.

54677 (TID—27629-P1P2) **Feasibility study on the impact of agencies and codes on university and college energy use. Volume II. Source data.** (Association of Physical Plant Administrators of Universities and Colleges, Washington, D.C. (USA). Energy Project Office). Mar 1977. Contract EG-77-X-01-2119. 162p. Dep. NTIS, PC A08/MF A01.

The Association of Physical Plant Administrators of Universities and Colleges assisted the Energy Research and Development Administration in a feasibility study to determine the impact of agencies and organizations that review and apply codes and standards to new construction and major renovation projects affecting colleges' and universities' ability to use and conserve energy. A questionnaire was prepared, setting forth two theoretical models, Major Building exceeding $2,000,000, and a Major Renovation exceeding $100,000, and used as a basis for information gathering. The program involved a survey of four representative states: (1) California, moderate climate, West Coast; (2) Maryland, moderate climate, East Coast; (3) Michigan, cold climate/heating region, North; and (4) Texas, warm climate/cooling region, South. Within each state, four institutions were analyzed, one from each of the following types: (1) two-year public community or junior college; (2) four-year public college; (3) public university; (4) four-year private college/university. The recommendations and conclusions of the survey are contained in the Executive Summary, Volume I. The Source Data are set forth in Volume II.

54678 **State of Maine state energy conservation plan.** Augusta, ME; State of Maine Office of Energy Resources (1977). 104p. (NP—22114).

The intent of the Plan is to reduce the amount of energy consumed in the State of Maine by 5 percent by 1980 by reducing the quantity of energy wasted in the state while maintaining or raising the socio-economic quality of life of its people. The specific programs for thermal and lighting efficiency standards, procurement standards, transportation measures, righ-turn-on-red, building audits, business and industry programs, motor vehicle efficiency, energy conservation education, local energy management program, electric utility load management, and intergovernmental coordination are outlined. Data on estimated costs, energy savings, costs for selected measures, and an environmental assessment are provided. (MCW)

54679 **Toward a methodology for the implementation of energy saving technologies.** Howland, M.; House, P.W.; Bruck, H.W. (Univ. of California, Berkeley). *Water, Air, Soil Pollut.;* 7: No. 2, 221-224(Feb 1977).

ERDA (The Energy Research and Development Administration) was given the mandate to perform or cause to be performed the

research and development of alternative energy sources and energy-conserving technologies and strategies. However, answers to the energy dilemma not only depend upon the proof that a technology or strategies exist but that they reach the end user and actually conserve energy. At the same time there is an indication that R and D projects carried out by or supported by the Federal Government are seldom utilized. This lack of utilization can be partially blamed on a lack of concern and knowledge surrounding the implementation process. To avoid this pitfall in the case of energy research, the study outlined here is a beginning to understanding the implementation process and, specifically, the implementation of energy-saving technologies.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 53606, 53906, 53942, 54651, 54687, 54698

54680 Overview of the energy crisis. Stoller, H.M. (Sandia Labs., Albuquerque, NM). pp 1-6 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

The problem facing the United States is that our demand for energy has, over the past years and in an ever widening margin, exceeded our capacity, with internal resources, to supply that energy. A quick look at the individual components of the USA energy supply illustrates that the problem is multifaceted. In petroleum, the U.S. had long been the world's leader in production, but today we are third, behind Saudi Arabia and the U.S.S.R. More importantly, domestic production peaked in 1970 with the critical result that the U.S. now imports approximately 35% of its crude oil requirements. In natural gas, not only does the demand currently exceed the supply, but in 1974, for the first time, the production of natural gas fell by 4%. Curtailments of interstate gas shipments for 1975 are estimated to reach 2 trillion cubic feet, or approximately 10% of production. In coal, although the shift away from coal usage to oil and natural gas for economic and environmental reasons has allowed the coal industry to meet its demands, total production has stayed approximately constant over the past two decades. Individual productivity in underground mining has shown a fairly significant drop over the past few years. Both trends must be reversed and quickly if our vast resources of coal are to be used as alternative souces of supply to petroleum and natural gas. In nuclear energy, after years of promise, safety and environmental concerns have caused a substantial slowdown in the growth of electricity generated by nuclear energy. Measures must be taken to allow nuclear energy to contribute more effectively. Symptoms exist that the U.S. may be vulnerable to cartel pressures with respect to uranium supplies as is currently the case in crude oil. To reiterate, no one element of energy supply is singularly critical; major problems exist in all elements.

54681 Outlook for energy resource development in Alaska. Wilson, W.W. Chicago; Continental Illinois National Bank and Trust Company of Chicago (1976). 10p. (CONF-7605155—1).

From Alaska Bankers Association Convention; Anchorage, Alaska, United States of America (USA) (10 May 1976).

It had been predicted that the discovery and development of the oil resources at Prudhoe Bay would act as a catalyst to stimulate exploration of other natural resources. The regional geology of Alaska suggests that very important coal resources and hard-mineral ore bodies are present in many parts of the state. Numerous mineral prospects have been at least partially explored and eventual commercial discoveries can be expected, given reasonable incentives and improved transportation facilities. The North Slope pipeline access road is but one example of the type of improvement that will open up hitherto difficult access areas to full-scale mineral development. The resource base is well-established and the need for both the raw materials and the energy fuels are unquestioned. Exploration for copper, gold, nickel and other minerals has continued in Alaska, notably in the Southeast part of the State, but coal, rather than gold, will now become the long-term choice. The Alaska Division of Geology and Geophysics suggests that the coal resources of Alaska may be as much as 2 trillion tons, which would be more than the identified coal resource base of the entire Lower 48 states. The location and potential for various coal deposits are examined. Then, the proposed tax policies that may prove to be detrimental to development are reviewed. The author cites a paper, Alaska's Prudhoe Bay Oil: Profitability and Taxation Potential, by M. Tanzer, which is a blueprint in the art of establishing tax policies and specifically analyzes the taxation potential of the Sadlerochit reservoir of the Prudhoe Bay field. (MCW)

54682 Energy for industry, 1977. Cambridge, Eng.; Cambridge Information and Research Services Limited/The British Gas School of Fuel Management (1977). 192p. .

This is the second edition of the annual survey of developments in the British fuel markets and their implications for industrial and commercial customers. This new edition employs a simple chapter scheme. Chapter 1 summarizes principal findings from the survey. Chapters 2 and 3 deal with the underlying trends and recent developments in energy supply and demand, firstly from an international standpoint and secondly from a U.K. viewpoint. With North Sea oil coming on stream in increasing quantities, there still seems little prospect that pricing levels will differ from those prevailing on the international market. Chapter 4 addresses the key question of energy conservation. Recently released fuel consumption figures suggest that while substantial and on-going economies are being made in the domestic sector, insufficient progress has been forthcoming from the industrial and commercial markets. It is a matter of particular importance to the industrial market that is now hopefully on the point of output recovery. It is vital in the long-term energy balance to avoid a return to fuel-consumption growth commensurate with output expansion. The following four chapters provide standardized profiles on the fuel-supply industries. Each contains a review of developments in 1975 and 1976 and goes on to examine the questions of structure and supply base, conservation and customer liaison, and sales and market penetration. Chapter 9 contains results of the pricing survey; a review of recent developments is followed by portraits of the pricing characteristics of each fuel. The final chapter attempts to take a forward view and includes a summary of estimates on supply and demand until 1990. Additional information is included in 4 appendices. (MCW)

54683 Alternative Danish energy planning. Blegaa, S. (Technical Univ. of Denmark, Lyngby); Josephsen, L.; Meyer, N.I.; Soerensen, B. *Energy Policy;* **5**: No. 2, 87-94(Jun 1977).

In the spring of 1976 the Danish government published an energy plan for Denmark for the period up to 1995. An essential part of this plan was the introduction of five nuclear power plants in the Danish supply system. An alternative energy plan which excluded nuclear power was later published by a group of Danish scientists. It includes a relatively extended application of solar and wind energy, and also emphasizes the use of decentralized fossil fuel plants with combined power production and district heating. This paper describes the main features and data of the alternative Danish energy plan and compares it with the official government plan.

54684 Energy alternatives within NATO. Sudarskis, M. (NATO, Brussels). *Energy Policy;* **5**: No. 2, 165-167(Jun 1977).

The aim of the NATO Committee on the Challenges of Modern Society (CCMS) Pilot Studies on Energy is to provide nations with as many as possible of the technical options available. The CCMS strategy is to suggest which technologies may be relevant and to accord priorities. Recognition of the finite nature of the earth's energy resources has created a new awareness of the importance of alternative sources such as solar and geothermal energy. CCMS Pilot Study on Geothermal Energy is currently underway. The study covers most of the main technical and scientific aspects which arise from geothermal energy exploitation: improvement of techniques for hot water uses, reservoir technology, brines reinjection, dry-hot rocks experiments. Among the projects the study of a small, portable and modular geothermal power plant up to 5 MV may provide interesting results. The CCMS Pilot Study on Solar Energy exchanges information on the performance of solar heating and cooling projects being undertaken by many countries. The CCMS review would accelerate the international solar house surveys which aim at cataloging all the existing solar houses or solar heating systems. The CCMS study reports upon experiments in NATO and non-NATO countries, e.g., Brazil, Jamaica, Israel, Saudi Arabia, the Bahamas, El Salvador, and the Philippines. Better utilisation of energy is as important as the production of alternative sources. Presently the CCMS projects deal with energy use in the steel, cement, and plastics industries. Energy consumption in the brewing industry is under investigation. (MCW)

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 54655, 54659, 54661, 54665, 54675, 54683, 54689, 54692, 54708

54685 (PB—265345) Politicians and professionals: interactions between committee and staff in state legislatures. Huwa, R.; Rosenthal, A. (Rutgers--the State Univ., New Brunswick, N.J. (USA). Eagleton Inst. of Pollution). Jan 1977. 34p. NTIS, PC A03/MF A01.

The Staff-Committee Interaction (SCI) project is designed to explore what happens in the dealings between the members and staffs of standing committees of state legislatures. In the SCI project, the targets of inquiry are twenty standing committees--those with

jurisdiction over the policy domains of education, natural resources, and energy. First, the authors explore an aspect that has significant effects on the interaction process--the divergence between legislator and staff roles. Second, the authors describe what committees mainly need from staff and how staff generally responds. Committee needs and staff tasks involve procedural information much more than policy information. Most committee demand and most staff effort concern information of an essentially procedural nature, requiring activities such as drafting, scheduling, summarizing, assembling, briefing, reporting, enacting, and servicing. Third, the authors identify seven types of factors, all relating to the improvement of staff-committee interaction--linkage, structure, proximity, relevance, attention, repetition, and reinforcement.

54686 (TID—27693) **Compilation of selected non-nuclear energy legislation.** (Energy Research and Development Administration, Washington, D.C. (USA)). 1977. 492p. Dep. NTIS, PC A21/MF A01.

Nineteen legislative actions dealing with non-nuclear energy are collected here. Section A, Organic Legislation Directly Related to ERDA includes: Energy Reorganization Act of 1974, Public Law 93-438; Federal Non-nuclear Energy Research and Development Act of 1974, Public Law 93-577; Solar Heating and Cooling Demonstration Act of 1974, Public Law 93-409; Geothermal Energy Research, Development, and Demonstration Act of 1974, Public Law 94-410; Solar Energy Research, Development, and Demonstration Act of 1974, Public Law 94-473; and Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976, Public Law 94-413. Section B, ERDA Authorizing Legislation, includes: Energy Research and Development Administration Appropriation Authorization Act for Fiscal Year 1976, Public Law 94-187. Section C, ERDA Appropriation Legislation, includes; Second Supplemental Appropriation Act for Fiscal Year 1975, Public Law 94-32; Continuing Appropriations for Fiscal Year 1976, Public Law 94-41; Department of the Interior and Related Agencies Appropriation Act for Fiscal Year 1976, Public Law 94-165; Public Works for Water and Power Development and Energy Research Appropriation Act for Fiscal Year 1976, Public Law 94-180; Second Supplemental Appropriations Act for Fiscal Year 1976, Public Law 94-303; Public Works for Water and Power Development and Energy Research Appropriation Act for Fiscal Year 1977, Public Law 94-355; Department of the Interior and Related Agencies Appropriation Act for Fiscal Year 1977, Public Law 94-373; and Continuing Appropriations for Fiscal Year 1977, Public Law 94-473. Section D, Related Energy Legislation, includes: Federal Energy Administration Act of 1974, Public Law 93-275; Energy Supply and Environmental Coordination Act of 1974, Public Law 93-319; Energy Policy and Conservation Act, Public Law 94-163; and Energy Conservation and Production Act, Public Law 94-385.

54687 **Energy 1976: considerations underlying a Dutch National Energy Research Programme.** The Hague; Government Publishing Office (1977). 94p.

The first tasks of the National Energy Research Steering Group (LSEO) were to compile an inventory of energy research in the Netherlands and to draw up a national programme in broad outline. The National Energy Research Programme was drawn up in two stages. In the first stage general observations were made on the consequences of a continual growth of energy consumption. Research proposals were formulated with regard to long-term options (noticeable effect possible in 20 to 30 years). Criteria were also developed for research within the framework of a National Programme and the broad outlines of a financial and an organizational structure drawn up. The results of this first stage were set out in an Interim Report, a summary of which is included here. In the second stage research proposals were formulated, inter alia in connection with short- and medium-term energy problems (1975-2000). This period involves a gradual transition from the present situation—which can only be determined by policy—to future situations, which can be influenced by the results of research and development. In February 1976 the LSEO submitted a summary of the considerations with regard to the future energy pattern and the resultant research proposals and recommendations. In the present report the LSEO presents the considerations underlying the research proposals and recommendations. It is based on a scenario in which it is assumed that there will only be a limited and declining growth in primary energy consumption, which could result in a stabilization of consumption around 1990-1995. It is clear that coal and uranium are the only realistic options up to the end of the century. (MCW)

FOSSIL FUELS

REFER ALSO TO CITATION(S) 54648, 54658

54688 (PB—265478) **Impact of coal and oil shale products on gasoline composition 1976-2000. Task I. Final report 1 Feb-Dec 76.** Newman, F.M.; Russell, J.A.; Bowden, J.N.; Johnston, A.A. (Southwest Research Inst., San Antonio, Tex. (USA). Mobile Energy Div.). Dec 1976. Contract EPA-68-03-2377. 41p. NTIS, PC A03/MF A01.

Report on Identification of Emissions from Gasolines Derived from Coal and Oil Shale.

A consensus assessment is made of the impact of coal- and oil shale-derived crudes upon the composition of gasoline. It is concluded that this impact will be negligible, since the most promising area for utilization of such crudes will be as burner fuels and middle distillates. Such utilization of coal and oil shale resources will in turn reduce the demand on petroleum resources which will continue to be the principal source of gasoline for the remainder of the 20th century.

54689 (PB—265488) **The Strategic Petroleum Reserve and liquefied natural gas supplies. Final report.** Fink, R.J.; Bancroft, B.A.; Palmieri, T.M. (TRW, Inc., McLean, Va. (USA). Energy Systems Planning Div.). 15 Feb 1977. Contract FEA-CR-04-60918-00. 83p. NTIS, PC A05/MF A01.

The United States is planning to import liquefied natural gas (LNG) to offset the effects of our apparent dwindling natural gas supply. These imports would begin by the 1980s and would come from Algeria, Indonesia, Pakistan, Iran, Nigeria, and possibly the Soviet Union. If a disruption in LNG supplies were to occur, the impact to the nation could be eased by supplying oil to those with dual fuel (oil or gas) capability. The Strategic Petroleum Reserve (SPR) could be called upon to supply this oil if an LNG embargo were to occur simultaneously with a foreign oil embargo. This report analyzes the impact which would be caused by an LNG embargo alone and a simultaneous LNG and oil embargo.

54690 (PB—265633) **Projects to expand fuel sources in western states. Survey of planned or proposed coal, oil shale, tar sand, uranium, and geothermal supply expansion projects, and related infrastructure, in states west of the Mississippi River (as of May 1976).** Corsentino, J.S. (Bureau of Mines, Denver, Colo. (USA). Intermountain Field Operation Center). Sep 1976. 222p. (BM-IC—8719). NTIS, PC A10/MF A01.

This report is a listing of fuels-related projects that are presently under construction, planned, or proposed by various companies and organizations in the Western United States. The future facilities covered fall into the following categories: coal mines and expansions to existing mines, electric powerplants and waste-to-fuel conversion plants, oil shale projects, tar sands projects, potential geothermal facilities, coal slurry pipelines, railroads related to fuels development, uranium mines and enrichment facilities, oil refineries, and natural gas processing plants.

COAL

REFER ALSO TO CITATION(S) 53604, 53633, 53634, 53635, 53645, 53646, 53657, 53705, 53709, 53716, 53717, 53727, 53744, 53745, 53747, 53819, 54239

PETROLEUM

REFER ALSO TO CITATION(S) 53872, 53873, 53906, 53913

54691 (PB—265616) **Opec and the experience of previous international commodity cartels. Working paper.** Eckbo, P.L. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Aug 1975. 46p. (MIT/EL—75/008WP). NTIS, PC A03/MF A01.

Sponsored in part by Department of the Interior, Washington, D.C.

A review was made on the efficiency and longevity of international cartel agreements using 51 cartels in 18 industries for analysis. Cartel success or efficiency was defined in terms of the ability of the organization to raise prices at least 200% above the unit costs of production and distribution.

54692 (PB—266001) **State information needs related to onshore and nearshore effects of OCS petroleum development.** Williams, D.C.; Stang, P.R.; Hyde, B. (National Oceanic and Atmospheric Administration, Rockville, Md. (USA). Office of Coastal Zone Management). Jan 1977. 191p. NTIS, PC A09/MF A01.

Prepared jointly by Bureau of Land Management, Washington, D.C. Div. Minerals Program Development and Analysis.

The United States currently has underway a program to develop tracts on the Outer Continental Shelf (OCS) for their petroleum resources that can have significant impact on and near the shore. The potentially affected States bordering the Atlantic and Pacific Oceans and the Gulf of Mexico have expressed serious concerns about the availability and adequacy of the information they need to make planning and management decisions about onshore activities and impacts related to OCS petroleum development. This report discusses state policies, major concerns, organization, planning approaches and relation to other state planning efforts.

54693 Outer Continental Shelf Lands Act Amendments of 1977. Report of the Committee on Energy and Natural Resources, United States Senate, together with Minority views to accompany S. 9. Washington, DC; Committee on Energy and Natural Resources (1977). 231p. GPO.

The Committee on Energy and Natural Resources, to which the bill S.9 was referred, submitted this report, together with minority views to accompany the bill. S.9 was to establish a policy for the management of oil and natural gas in the Outer Continental Shelf; protect the marine and coastal environment; and amend the Outer Continental Shelf Lands Act. The committee recommended that the bill pass. The bill is published in full, and major provisions are summarized, along with the background and need. Following a review of its legislative history, additional information is included on recommendations; tabulation of votes; committee amendments; a section-by-section analysis; cost and budgetary considerations; regulatory impact evaluation; and executive communications. The changes made by S.9 in three existing acts conclude the report. (MCW)

54694 EEC demand for imported crude oil, 1956—1985. Kouris, G.; Robinson, C. (Univ. of Surrey, Guildford, Eng.). *Energy Policy;* **5**: No. 2, 130-141(Jun 1977).

The authors develop here a model which analyses the EEC demand for imported oil, basing the analysis on functional relationships with real income and price. They conclude that net imports into the EEC in 1985 will be sensitive to future oil prices. If no UK oil were available then it might be necessary to double real oil prices to meet an objective of holding net imports to their 1973 levels. However, the existence of UK oil should allow this goal to be achieved with much lower price rises, probably around 30 to 50%, but perhaps as low as zero.

54695 Price of crude oil in the international energy market: a political analysis. Maull, H. (Trilateral Commission, Paris). *Energy Policy;* **5**: No. 2, 142-157(Jun 1977).

Political processes, claims the author, offer the chief explanation of price trends in the international oil market. Although these processes take place within an economic framework, the band between the costs of production and those of alternative sources of energy within which prices could move, is so large that it has lost much of its practical effect in determining prices. A number of actors are identified whose interaction principally determines prices. The historical developent of this interaction is traced and the author concludes that it may ultimately be in the interests of all actors—producers, consumers, companies, and developing nations—to coordinate their efforts in synchronizing the introduction of new energy sources to replace oil.

54696 Recent world oil pricing: the Saudi enigma. Mancke, R.B. (Tufts Univ., Medford, MA). *Energy Policy;* **5**: No. 2, 167-168(Jun 1977).

The traditional behavior of a monopoly supplier is to maximize its profit. Yet Saudi Arabia, the dominant world supplier of oil, is the chief proponent within OPEC of moderate price increases. This article suggests reasons why. Possibilities include (1) the Saudi desire to cooperate with the West in return for help in resolving the Arab-Israeli conflict; (2) their wish to minimize damage to developing countries short of oil; or (3) their desire not to weaken the non-Communist West's military and industrial well-being. These possibilities are elaborated. (MCW)

NATURAL GAS

REFER ALSO TO CITATION(S) 53913, 53942, 54693

54697 (NP—22127) Impact of California natural gas shortages on electricity demand. Final report. (TRW Energy Systems Management Div., Redondo Beach, Calif. (USA)). 17 Jan 1977. 109p. Energy Systems Management Div., Redondo Beach, CA.

Even without adopting special conservation (and solar) techniques, gas shortfalls in the residential sector will be small in the period 1977-1995. Specifically, only Northern California residents are projected to be slightly curtailed by 1995, and such curtailment could be prevented by gas interchange between Southern and Northern California utilities. The commercial sector is projected to be impacted by gas curtailments by 1990 in Northern California and by 1995 in Southern California, if no special conservation measures are taken. If conservation measures are adopted, gas curtailments in both the residential and commercial sectors would be essentially nil. The industrial sector (assuming no residential or commercial conservation) is projected to be severely impacted by gas shortages with some curtailment occurring before 1980, but fuel oil will be the primary alternate to gas for industry. Minor switches from gas to electricity are projected, but this increased demand may be balanced by increased industrial on-site power generation. Thus, no substantial shift to electricity is foreseen. The price of electricity is expected to be higher than the price of comparable units of gas during the time period of interest. It is possible though that the price of gas may increase relative to electricity and some switching for economic reasons may occur in the residential and commercial sectors. Such switching would be slow since a stock of gas appliances would have to be replaced. Switching to electricity because of expectations of gas shortages by residents is also possible unless residents are convinced that they will not be impacted. 19 tables, 14 figures.

54698 Role of gas in world energy. Clark, L.J. *Gas Eng. Manage.;* **16**: No. 6, 185-194(Jun 1976).

A critical discussion includes the higher value of gas as energy compared with coal energy in general correlations of GNP with energy consumption; world-wide development of the use of natural gas; the limited nature of natural gas resources and the need to direct gas to domestic heating and other premium uses; the need to extend the life of the gas resource rather than replace it with electricity (e.g., gas supplies four times as much energy as electricity in the U. S. and the electric industry requires over nine times as much investment as gas to supply the same quantity of energy); future energy needs; and prospects for new gas sources including gas from coal, gas from seaweed, gas (hydrogen) from nuclear energy, and the prospects for finding new reserves of natural gas. Table, graphs, and maps.

54699 Gas supplies of interstate natural gas pipeline companies, 1975. Washington, DC; Federal Power Commission (1977). 122p.

This report on the gas supplies of interstate natural gas pipeline companies for calendar year 1975 is the twelfth report on the gas supplies of these companies since the inception of individual company reports to the Federal Power Commission in 1963. This report provides a statistical summary of the year-end 1975 total reserves and deliverability of the interstate pipeline companies filed by 91 pipeline companies required to report on their gas supplies for 1975. The data on dedicated in-the-ground gas reserves (company owned and/or purchased from independent producers) are from reports filed by 60 of these companies. The remaining 31 companies purchase all their gas supply from other pipeline companies. The gas supplies of interstate pipeline companies consist of the certificated, dedicated, recoverable, salable natural gas available from domestic in-the-ground reserves, gas purchase contracts with other interstate pipeline companies, foreign suppliers, and substitute natural gas (SNG) suppliers.

ELECTRIC POWER

REFER ALSO TO CITATION(S) 54656

54700 Values in the electric power industry. Sayre, K. (ed.). Notre Dame, IN; University of Notre Dame Press (1977). 310p.

A basic conclusion established by the seven essays presented is that nowhere within the complex decision-making process of the electric power industry is there any provision for systematically considering the curtailment of consumption as a serious alternative to continued expansion of power production. Six recommendations are summarized for concrete steps toward remedying this deficiency as a result of examining the essays. Continued expansion of power generation could result in desirable consequences of economic growth, jobs, ready transportation, and many consumer conveniences; undesirable consequences are: increasing air and water pollution, further depletion of nonrenewable resources, and increased dependence on foreign sources of energy. The papers are: A Cybernetic Analysis of Certain Energy Consumption Patterns, by Kenneth Sayre; Social and Environmental Value in Power Plant Licensing: A Study in the Regulation of Nuclear Power by Vaughn McKim; Legal and Economic Aspects of the Electric Utility's "Mandate to Serve", by Charles Murdock; Economies of Scale in the Electric Power Industry, by Kenneth Jameson; Dynamics of Growth in the U.S. Electric Power Industry, by Ellen Maher; Utilitarianism and Cost-Benefit Analysis: An Essay on the Relevance of Moral Philosophy to Bureaucratic Theory, by Alasdair MacIntyre; and An Ethical Analysis of Power Company Decision-Making, by Kenneth Goodpaster and Kenneth Sayre. (MCW)

54701 FPC releases preliminary 1976 power production, capacity, fuel consumption data. Washington, DC; Federal Power Commission (1977). 17p.

Preliminary data show that the nation's electric utilities produced a record 2,036,486,503 megawatt hours of electricity in 1976, 6.2 percent higher than in 1975. The installed generating capacity of the nation's electric utilities also reached a record level of 531,287 megawatts during 1976, up 4.5 percent from 508,251 megawatts in 1975. Steam-electric plants had a total installed capacity of 411,615 megawatts at the end of 1976, including 42,919 megawatts of nuclear-fueled capacity. Hydroelectric stations had a total installed capacity of 67,798 megawatts. Internal combustion plants had a combined capacity of 5,298 megawatts and gas turbine plants, 46,576 megawatts. Power output by fuel-burning plants in 1976 totaled

1,752.8 million megawatt-hours, 8.4 percent greater than in 1975. Hydroelectric plants produced 283.7 million megawatt hours in 1976, compared with 300.0 million in 1975. To produce electric energy in 1976, utilities burned 448.1 million tons of coal; 555.4 million barrels of fuel oil; and 3,078 billion cubic feet of natural gas. In 1975, fuel consumption totals were: coal, 406.0 million tons; oil, 506.1 million barrels; and gas 3,158 billion cubic feet. In 1976, privately-owned utilities generated 1,582.0 million megawatt-hours and publicly-owned utilities generated 454.5 million megawatt-hours. Data on electric utility generating capacity and production by region, state, and type of plant; production of electricity and installed generating capacity by class of ownership; and power production by kind of fuel and related amount of fuel burned are tabulated. Fuel data are also given by region and state.

54702 Economic analysis of electric power projects. Berrie, T.W. (World Bank, Washington, DC). *Int. Water Power Dam Constr.;* **29**: No. 6, 29-31(Jun 1977).

This article deals with the problem of judging whether or not a proposed electric power project is likely to benefit the economy to justify the required expenditure of public resources. The perspective is therefore economic and financial, rather than technical. Analysis relies on three types of tests, all of which employ the discounting cash flow techniques; the only way to give proper recognition to the time value of money: (a) the internal economic return (IER) i.e., the discount rate which equalizes the present values of the benefit and cost streams over the life of the project; (b) the benefit/cost ratio (B/C ratio), a comparison of the present worth of benefits and costs based on an assumed test rate of discount; and (c) the net present worth (NPW) or the difference in present worth of benefits and costs. The significance of the opportunity cost of capital, the effects of risks and uncertainties, and assessment of benefits are discussed. (MCW)

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 53819, 53906, 54239, 54241

54703 (COO—2865-5) Effects of redefining the system boundary on the net energy of electricity-generating systems. Amado, D. (Illinois Univ., Urbana (USA). Center for Advanced Computation). Feb 1977. Contract EY-76-S-02-2865. 18p. Dep. NTIS, PC A02/MF A01.

The conventional method of determining energy costs tallies only the cost for materials purchased on current account, and assigns no energy cost to activities such as government research, development, and regulation of the energy industry. It is argued that these activities be redefined as energy costs and included in net energy calculations, thereby increasing the energy cost of energy facilities. This approach was generally endorsed at the NSF/Stanford Net Energy Workship (1975) and is implemented for the first time in this report. The system boundary is redefined for both an oil-fired power generation plant and the light-water reactor system. In general, it is concluded that even after redefining the system boundary by including capital investment, regulation, and R and D as an energy cost and after computing "upper bound" inputs using fairly conservative estimates, both the LWR system and the crude oil system of electricity generation are net energy producers. Nuclear energy is still seen to be the more efficient of the two. (MCW)

54704 (NP—22153) Future possibilities of bituminous coal in the field of electric power generation. Hildebrandt, R. (Technische Hochschule Aachen (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet). 3 Jun 1976. 88p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

Thesis.

Testing the future chances of hard coal as fuel for electric power production, consumption of total primary energy was used as a basis. The world, the U.S., and the FRG show a regularity of total consumption of primary energy. The forecast of total energy need and meeting it with fossil primary energy sources shows that, with constant consumption tendency of each primary energy source, an energy gap develops despite the increasing share of nuclear energy. For closing this gap, coal is thought to be best, especially because of the large resources in the FRG and in the world. Examination of all power plant plans shows that light-water reactors (LWRs) used today should be replaced by high-temperature reactors and finally by breeders. This is necessary because of the low efficiency and the small amount of safe stored cheap nuclear fuels. As future technologies based on coal, the combined gas-steam power plants with coal pressure gasification and fluidized-bed firing are worth developing because of their harmlessness to the environment and their good efficiency. The LWR is compared with the gas turbine reactor on the basis of coal; special stress is laid on the influence of fuel and investment costs on current production costs. Since in the case of nuclear power plants the share of investment costs is very high, changing these costs strongly influences current production costs. The result is a further decrease of financial advantages of nuclear power plants despite slightly increasing costs for hard coal and a normal average rate of inflation of about 5 percent. Thus, the hard coal power plant might be able to compete with the nuclear power plant (LWR) in the next decade in the region of medium load. 78 references

54705 (TID—27682) Operational status and current trends in gas turbines for utility applications in Europe. Harmon, R.A. (Energy Research and Development Administration, Washington, D.C. (USA)). 16 Aug 1976. Contract EX-76-X-01-0016. 135p. Dep. NTIS, PC A07/MF A01.

European gas-turbine manufacturers have been subjected to the same broad business and economic pressures experienced in the U.S., inflation, tight money, business recession, depletion of energy resources brought into focus by the 1973 oil embargo, nationalistic desire for energy independence or reduced oil imports, and conflicting concern for the environment and long-term public health and safety. As a result, utility load growth approached zero and even experienced negative percentages in 1974 and 1975. Correspondingly, the market for utility-type turbines almost disappeared in Europe; consequently, most utilities had excess reserve generating capacity, some as high as 40 percent. Gas-turbine manufacturers survived by supplying markets in oil-producing countries, developing countries, and sections of the market less affected by the business recession (oil and gas; chemical and process industries). With business activity recovering at the beginning of 1976, power demand also began to rise again. With retirement of old or less-efficient equipment and absorption of the excess reserve capacity, requirements for new machines are anticipated, some as early as 1978. Activity in this direction is apparent in discussions, quotes, and some orders for new plants. The impact of these general trends on gas-turbine operation and design trends is summarized. Gas turbines are expected to play an important and continuing role in the utility industry in accordance with its changing requirements.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 54677, 54739

54706 State of Illinois tillage and energy survey. Springfield, IL; Agricultural Energy Advisory Committee (1975). 19p. (NP—22149).

Changes in corn and soybean tillage practices have been made since 1970 by 45.5 percent of Illinois farmers. The major changes in tillage practices of these farmers have been more chisel plowing and field cultivating along with wider use of herbicides while amounts of moldboard plowing and crop cultivating have been reduced. Most farmers who have changed practices listed more than one reason for changing. To save time was listed by 69 percent, save fuel by 62 percent, reduce cost by 62 percent, herbicides have become available by 57 percent, and reduce erosion by 52 percent. The major reason expressed by those farmers not changing practices was concern that weed problems would develop. Larger farmers in the State have been more likely to change practices than farmers with 250 acres or less of cropland. Diesel tractors were generally preferred for plowing, field cultivating, herbicide incorporation, and disking. Gasoline tractors were preferred for planting and rotary hoeing. Less than half of the farms under 250 acres of cropland reported that diesel tractors were used.

54707 Modular Integrated Utility System (MIUS) as a potential influence on community development. Mixon, W.R. (Oak Ridge National Lab., TN). *Water, Air, Soil Pollut.;* 7: No. 2, 261-269(Feb 1977).

The Department of Housing and Urban Development (HUD) is conducting the Modular Integrated Utility System (MIUS) Program devoted to development and demonstration of the technical, economic, and institutional advantages of integrating the systems for providing all or several of the utility services for a community. Possible utility services include the provision of electric power, domestic heating and cooling, potable water, fire protection water, liquid waste treatment, and solid waste management. The objective of the MIUS concept is to provide the desired utility services in a way that is consistent with reduction in the use of critical natural resources, protection of the environment, and minimization of cost. A MIUS might be sized to accommodate several hundred or a few thousand multifamily dwelling units, nearby single-family housing, and associated commercial facilities. The MIUS is modular in that it can be installed near appropriate users in phase with the actual demands of community development or redevelopment. It uses an integrated systems approach whereby some resource requirements of one service are met by utilizing the effluent of another. For example, heat rejected from electrical generation might be used for residential space heating, and the effluent from liquid waste treatment might be used for fire protection and/or cooling tower water. The paper summarizes the MIUS concept and the type and extent of potential application. Possible interactions between MIUS and the local community are identified from a comparison of technological and phys-

ical characteristics of MIUS with alternative conventional utilities. Possible impacts on land use and patterns of community development are emphasized.

54708 Impact of the energy crisis on the demand for fuel efficiency: the case of general aviation. Archibald, R.B.; Reece, W.S. (Dept. of Labor, Washington, DC). *Transp. Res.;* **11**: No. 3, 161-165(Jun 1977).

One of the most important questions accompanying the debate over energy policy is whether or not consumers will react to increased fuel prices by choosing more fuel efficient transportation modes. This paper addresses this question by developing a theoretical rationale for the hypothesis that the energy crisis has induced an increase in the demand for fuel efficiency as a characteristic of aircraft and empirically tests this hypothesis with data from the U.S. general aviation market. 17 refs.

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 54684

SOLAR

REFER ALSO TO CITATION(S) 54093

54709 Guide to Federal programs of possible assistance to the solar energy community. Prepared for the Committee on Science and Technology, U.S. House of Representatives, Ninety-Fourth Congress, Second Session. Washington, DC; Library of Congress (1976). 537p. GPO.

This report is a guide to existing Federal programs that may in some way assist individuals and organizations interested in applications or advancement of solar conversion technology. It identifies a variety of informational and financial assistance programs available through 21 agencies of the Federal Government. Thus far no financial assistance program has been established specifically for solar interests, but some programs may be applied to solar programs even though they were established for some other purpose. Of the 21 agencies identified, six offer some form of financial-assistance: The Farmers Home Administration; The Rural Electrification Administration; The Economic Development Administration; The Office of Minority Business Enterprise; The Farm Credit Administration; and The Small Business Administration. The agencies offering information, addresses, and informational brochures on solar interests are identified. (MCW)

GEOTHERMAL

REFER ALSO TO CITATION(S) 54159, 54690

OTHER

54710 Solid waste management for energy utilization and resource recovery, an economic approach. Konsavage, J.G. University Park, PA; Pennsylvania State University (1977). 14p. (NP—22095).

The goal of this paper is to show that through energy utilization and resource recovery from solid waste the dichotomy between the nation's energy needs and desire for ecological purity can be resolved. Three pertient technologies, solid waste as fuel, incineration, and pyrolysis, are discussed in Section 1. Market ability, Public Goods of the System, Economies of Primary vs. Secondary Resource Supply are three sections that follow. In the concluding section, the public benefits derived from utilizing solid wastes are shown to be: it replaces the use of fossil fuels; it produces low sulfur oxide emissions; it reduces the amount of land needed for disposal sites; it is a readily increasing domestic source of energy; and it makes recycling possible by attaining economies of scale. (MCW)

ENERGY CONVERSION

MHD GENERATORS

DESIGN AND DEVELOPMENT

54711 (AD-A—038612) **High power density MHD generators. Final technical report.** Kessler, R. (Avco-Everett Research Lab., Everett, Mass. (USA)). Mar 1976. Contract F33615-75-C-2047. 60p. NTIS PCA04/MF A01.

Operating parameters were calculated for MHD generators operating at power densities in the channel of 500 MW/cu m and with power outputs of 30 - 35 MW (nominal). Liquid-fueled generators, using hydrocarbon fuels such as JP-4 or RP-1 and oxygen, and solid fuel generators were investigated. Designs of both liquid and solid fuel generators are described, and estimates of their weights and sizes are given. Operation of generators at power densities of 1000 MW/cu m was investigated. Assessments of feasibility and risks involved in achieving high power density operation are made. A development plan for construction of flightweight high power density MHD generator power supplies is presented.

54712 (N—77—17852) **Estimates of optimal generating conditions for hydrogen-oxygen cesium-seeded magneto-hydrodynamic power generator.** Smith, J.M.; Nichols, L.D. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Feb 1977. 37p. (NASA-TN-D—8374; E—8828). NTIS, PC A03/MF A01.

The value of percent seed, oxygen to fuel ratio, combustion pressure, Mach number, and magnetic field strength which maximize either the electrical conductivity or power density at the entrance of an MHD power generator was obtained. The working fluid is the combustion product of H_2 and O_2 seeded with CsOH. The ideal theoretical segmented Faraday generator along with an empirical form found from correlating the data of many experimenters working with generators of different sizes, electrode configurations, and working fluids, are investigated. The conductivity and power densities optimize at a seed fraction of 3.5 mole percent and an oxygen to hydrogen weight ratio of 7.5. The optimum values of combustion pressure and Mach number depend on the operating magnetic field strength.

54713 (TID—27729) **Research in coal-based magnetohydrodynamics. Quarterly technical progress report, October—December 1976.** Bienstock, D. (Energy Research and Development Administration, Pittsburgh, Pa. (USA). Pittsburgh Energy Research Center). 1976. 29p. Dep. NTIS, PC A03/MF A01.

Construction and equipment shakedown was completed at the nominal 5 megawatt MHD coal gasification-combustion pilot plant as well as the multitude of small problems of calibrations, instrument adjustments, torquing nuts and bolts, connecting water hoses, installing TV cameras, quartz windows, etc. all converging toward a long-duration run to dry combustor refractory. Initiation of the combustor refractory dry out was started at the end of the quarter. The refractory dry out run tested the first-stage air heater at its rated capacity of 1850°F and the design concept of the inconel-lined pipe. Experiments with one cyclone configuration were completed in the atmospheric high temperature (MHD) vertical cyclone gasifier-combustor and tests with a second have been initiated. Minor problems with coal feeding were overcome. A computer program, known as MASBAL has been formulated, that predicts the masses of potassium and sulfur compounds present at various key points of the MHD seed recovery and seed regeneration system. This program will substantially reduce the amount of time necessary for performing material balances on the seed processing system for a wide range of operating parameters. The combustor modeling facility has been modified so that air or water can be used as the modeling fluid. Two-phase flow simulation experiments with an air-driven cyclone model began this quarter. Flow visualization experiments with a cyclone water model indicate that vortex coupling with the slag tank can significantly affect the slagging performance of center-trap cyclone combustors. A second-stage axial flow combustor model was fabricated and flow modeling experiments will begin next quarter.

54714 (TID—27730) **Research in coal-based magnetohydrodynamics. Quarterly technical progress report, January—March 1977.** Bienstock, D. (Energy Research and Development Administration, Pittsburgh, Pa. (USA). Pittsburgh Energy Research Center). 1977. 27p. Dep. NTIS, PC A03/MF A01.

Several extended combustion tests with No. 2 fuel oil were conducted in the nominal 5 megawatt MHD coal gasification-combustion pilot plant. The tests confirmed the capability of operating at high temperature at six atmospheres pressure and the operability of the data acquisition system. Seventy-two coal pulverization runs were made to determine equipment configurations and parametric values necessary to achieve the desired range of pulverized coal particle size. The experimental program for the atmospheric high temperature (MHD) vertical cyclone gasifier-combustor was seriously disrupted by a 6-week curtailment in natural gas availability at PERC. However, a number of modifications were made to system components that will allow use of alternate fuels and improve the quality of future tests. Revised cost estimates were prepared for the PERC MHD seed desulfurization scheme. The base case situation analyzed involved a 2000 MW(t). 50 percent efficient MHD power plant, burning a 3.0 wt. percent sulfur coal, with SO_2 emissions meeting the EPA New Source Performance Standards (1.2 lb SO_2/10^6 Btu of coal burned). A linear programming code for estimating quench heat for slags and terminal oxidation conditions for heating value calorimetry has been written. Two-phase flow experiments with a cyclone flow model indicate that particle blowby, slagging, and performance will be affected by small amounts of air entering the cyclone chamber through the slag tap. Isolation of the slag tap

from any communicating air lines from secondary-air registers has lead to more consistent and predictable performance for the PERC atmospheric vertical cyclone. A mathematical model is being developed by PERC in conjunction with the Aeronautical Research Associates of Princeton. Verification of the model in terms of its ability to correlate performance for the PERC atmospheric verical cyclone is currently underway.

MATERIALS, COMPONENTS, AND AUXILIARIES

54715 (AD-A—038599) **MHD power generation (Viking series) with hydrocarbon fuels. Final technical report 7 Apr—15 Aug 75.** Kessler, R. (Avco-Everett Research Lab., Everett, Mass. (USA)). Sep 1975. Contract F33615-75-C-2047. 38p. NTIS PCA03/MF A01.

See also Rept. No. AFAPL-TR-74-47-Pt-3 dated Nov 74, AD-A—004216.

The design, fabrication and operation of a compact high-performance burner for a two megawatt MHD generator is described. The burner was designed to operate on hydrocarbon fuels and oxygen, with cesium seed, at mass flow rates up to 2.7 kg/sec, chamber pressures up to 15 atmospheres and with rapid start capability. The burner was operated to about 90% of its design mass flow and chamber pressure. Operation at higher flow rates was restricted by limitations of the test facility. Measured heat losses at high flow rates were approximately 9% of the enthalpy input. Starting times, to full chamber pressure, were about 0.3 seconds.

54716 **Long term stability of magnetic liquids for energy conversion devices.** Popplewell, J.; Charles, S.W.; Chantrell, R. (University Coll. of North Wales, Bangor). *Energy Convers.;* **16**: 133-138(1977).

A number of techniques for preparing ferromagnetic liquids containing small ferromagnetic particles dispersed in a metallic carrier are described. The fluids of this type may be used in energy conversion systems and particular emphasis is placed on factors governing stability. The effects of tin coatings on iron particles and the nature of the carrier fluid on stability are discussed together with the possibility of producing fluids with long term stability.

DUCT ENGINEERING AND FLUID DYNAMICS

54717 (ERDA-tr—295) **System for measuring the local electrical conductivity of plasma.** Balashov, N.A.; Gaponov, I.M.; Malyuzhonok, G.P.; Mikhailov, Yu.S.; Oberman, F.M.; Poberezhskii, L.P.; Stankevich, B.I. (AN SSSR, Moscow. Inst. Vysokikh Temperatur). 1975. Translation of USSR report. 40p. Dep. NTIS, PC A03/MF A01.

The system for measuring the local electrical conductivity of the plasma of products of combustion (SILYeP) is intended for investigation of the distribution of electrical conductivity of the ionized gas flows (plasma) and the determination of the electrical conductivity fluctuations. The measurement of the electrical conductivity is based on the change in the Q-factor of a circuit, in the vicinity of a conducting medium. The SILYeP system includes the following assemblies and components: electrical conductivity pickup, electronics packages consisting of electronic and power supply units, pneumatic drive for the pickup consisting of a drive mechanism, a device for registering the position of the pickup and auxiliary systems that supply electric power and provide cooling, control panel, connecting cables, and recorder. A schematic block diagram of the SILYeP system is shown.

THERMOELECTRIC GENERATORS

PERFORMANCE AND TESTING

54718 **Generalized analysis of thermoelectric device configurations.** Brandstetter, A. (Weizmann Inst. of Science, Rehovot, Israel); Chock, E.P. *Energy Convers.;* **16**: 125-131(1977).

Performance characteristics of a particular non-standard configuration thermoelectric generator concept, involving triangular prismatic shaped electrodes, are predicted following a detailed analytical determination of its two-dimensional temperature field. A peculiar result emerging from this analysis, namely the performance characteristics depending on only one "configuration" parameter lumping together all relevant configurational details, is tentatively generalized on the basis of Osterle's "unified theory of energy converters."

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 54718

54719 **Thermoelectric figure of merit of poor thermal conductors.** Dixon, A.J. (Lewes Technical Coll., Eng.). *Energy Convers.;* **16**: 139-141(1977).

Calculations are given to show that for low thermal conductivity materials the radiation losses at even moderate temperatures preclude the use of the Harman technique for measuring the thermoelectric figure of merit. Measurements on liquid $Tl_{66}Se_{34}$, which has suitable thermoelectric properties, confirm this.

THERMIONIC CONVERTERS

DESIGN AND DEVELOPMENT

54720 **Process for regulating the thermal conductivity of the excess power transfer medium of a thermal system.** Coche, J.-C. (to CEA, 75 - Paris (France)). French Patent 2298825/A/. 21 Jan 1975. 10p. (In French).

A description is given of a process to regulate the thermal conductivity of the transfer medium of a thermal system. It is characterized by the fact that the thermal resistance of the space between the hot and cold sources is adapted by installing in this space a transfer medium which associates a solid phase to the gaseous phase of a gas gap in order to regulate the temperature difference between the sources.

MATERIALS, COMPONENTS, AND AUXILIARIES

54721 (LA—6706-MS) **Ceramic materials for nuclear thermionic converters.** Cowan, R.E.; Stoddard, S.D. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1977. Contract W-7405-ENG-36. 10p. Dep. NTIS, PC A02/MF A01.

Ceramic-to-metal seals and pure oxide ceramics for use in the plasma thermocouple concept of nuclear thermionic power converters were developed to operate in a cesium-vapor environment at 1200°C. Hermetic seals of tungsten-metallized alumina brazed to niobium were developed that could be thermal cycled to above 1200°C. Magnesium-nickel ceramic-to-metal seals showed promise for use in thermal cycling to 700°C. An alumina-yttria body was used for metallizing with tungsten.

FUEL CELLS

DESIGN AND DEVELOPMENT

54722 (CONF-770531—2) **Molten carbonate fuel cell systems: status and potential.** Ackerman, J.P. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-31-109-ENG-38. 10p. Dep. NTIS, PC A02/MF A01.

From Meeting of the Electrochemical Society; Philadelphia, Pennsylvania, United States of America (USA) (8 May 1977).

Generating systems based on molten carbonate fuel cells provide some highly attractive solutions to an increasingly difficult national energy situation. Coal-fueled electric generators based on the molten carbonate fuel cell will have very low pollutant emissions and high efficiency (approximately 50 percent) at reasonable costs. This technology is also well suited to co-generation of electric power and high-grade heat, so that very high utilization of fuel energy content is possible. Molten carbonate fuel cells have three fundamental properties that make inexpensive, efficient generating systems possible. The first is good cell performance, mainly because kinetics of electrochemical and mass transport processes are rapid at the cell operating temperature of 925 K. The second is the suitability of the cells for use with carbonaceous fuels. Carbon monoxide is a fuel in this system, and not a poison as it is in low temperature fuel cells. The third property is that the heat generated by the cell is at a high enough temperature (approximately 925 K) for practical, economical use, either for direct application to industrial process, heating, and air conditioning, or in an integrated bottoming cycle in a purely electric generating system. These same advantages are also characteristic of other high temperature fuel cells, such as solid oxide cells, but the materials problems of the molten carbonate system appear to be more tractable, so that molten carbonate systems can be brought into use much sooner. An overview of the nature and development status of molten carbonate fuel cells is presented, and the areas where development effort is required are pointed out. Some applications of systems based upon molten carbonate fuel cells are briefly described.

54723 **Cost and size estimates for a redox bulk energy storage concept.** Warshay, M.; Wright, L.O. (Lewis Research Center, Cleveland). *J. Electrochem. Soc.;* **124**: No. 2, 173-177(Feb 1977).

Preliminary capital cost and size estimates were made for an electrochemical bulk energy storage concept. The electrochemical system considered was an electrically rechargeable flow cell with a titanium trichloride titanium tetrachloride//ferric chloride/ferrous chloride ($TiCl_3/TiCl_4/FeCl_3/FeCl_2$ redox couple. The preliminary calculations were made to help determine whether the redox-flow-cell system has an attractive potential as a bulk energy storage

system for power load leveling. On the basis of preliminary capital cost estimates, size estimates, and several other important considerations, the redox-flow-cell system emerges as having great promise as a bulk energy storage system for power load leveling. The size of this sytem would be less than 2% of that of a comparable pumped hydroelectric plant. The capital cost of a 10 MW, 60 and 85 MW-hr redox system is estimated to be $190 to $330 per kilowatt. This cost compares well with that of competing systems, especially when one considers that for many sites a saving in transmission costs (up to $200 per kilowatt) could be realized with the redox system. This saving could be achieved because the redox systems could be built in various sizes and located near the load centers. The other important features of the redox system contributing to its load-leveling application are its low adverse environmental impact, its high efficiency, its apparent absence of electrochemically related cycle life limitations, and its fast response.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 54724

APPLICATIONS

REFER ALSO TO CITATION(S) 54723

ELECTROCHEMISTRY, MASS TRANSFER, AND THERMODYNAMICS

54724 Oxidation of methanol on agitated bed electrodes using non-metallic electrocatalysts. Kurkowski, K.J.W.; Phillips, C.R. (Univ. of Toronto). *Energy Convers.;* **16**: 91-94(1977).

Agitated beds of various finely divided electrocatalysts were evaluated for the electrooxidation of methanol. This electrode configuration offers an extended surface area for applications such as fuel cells. On the basis of current increase per unit cost of catalyst, the catalysts could be ranked in decreasing order of effectiveness as: Mo—O—S, W—O—S, Cu_xS and activated carbon. The effective surface area of the finely divided catalyst was much less than the apparent surface area, most likely due to particle agglomeration.

POWER CYCLES

BRAYTON

54725 (N—77—17563) **Inspection of two Brayton rotating units after extensive endurance testing.** Dunn, J.H. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Dec 1976. 25p. (NASA-TM-X—73569;E—9013). NTIS, PC A02/MF A01.

A system was designed to produce 2 to 10 kW net continuous electric power for at least 5 years. The turbine-alternator-compressor power conversion unit in the system is designated Brayton Rotating Unit (BRU). Four BRU's were fabricated and extensively tested. One BRU has accumulated 11,000 hours of operation, and another has accumulated in excess of 21,000 hours. Testing has demonstrated that the BRU's have met or exceeded performance objectives. Two BRU's were disassembled and given a thorough post-test inspection. The inspection results show that after 21,000 hours of operation there is no apparent wear or failure mode that will prevent the attainment of the 5-year life objective.

54726 Use of liquid natural gas as heat sink for power cycles. Angelino, G. (Politec of Milan, Italy). *Am. Soc. Mech. Eng., [Pap.]:* No. 77-GT-19, 1-9(1977).

The thermodynamics of power cycles employing liquid natural gas (LNG) as heat sink is discussed. Condensation cycles in simple or in elaborate versions, employing nontoxic, nonflammable, inert organic fluids, (CF_4 C_2F_6, CHF_3, C_3F_8), yield the best overall $perf_\eta$ for LNG vaporization at subcritical pressure. For supercritical vaporization, heat rejection from Brayton cycles naturally fits heat sink thermal characteristics, which results in a particularly high efficiency for closed gas cycles. If only a fraction of the cooling capability of LNG is devoted to power uses, condensation cycles are superior to gas cycles even at supercritical LNG pressures. Under the most favorable circumstances gas cycles achieve efficiencies of around 60 percent, while some elaborate condensation cycles attain the 70 percent level.

54727 Internal forced convection to mixtures of inert gases. McEligot, D.M. (Univ., Karlsruhe, Ger.); Taylor, M.F.; Durst, F. *Int. J. Heat Mass Transfer;* **20**: No. 5, 475-486(May 1977).

Mixtures of inert gas can be used to improve performance in closed gas turbine cycles. In the present work, heat transfer and wall friction parameters have been obtained numerically to demonstrate the effects of mixture composition and gas property variation for heating or cooling in regenerative heat exchangers of such cycles; the situation is modelled by laminar flow through short ducts with constant wall heat flux. For design predictions accounting for the effect of property variation, it is found that the property ratio method is better than the film temperature method for heat transfer while the latter method is preferable for apparent wall friction—with the proviso that the present definitions of the non-dimensional parameters be employed.

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 54675, 54678

BUILDINGS

REFER ALSO TO CITATION(S) 54651

54728 (AED-Conf—76-262-001) **Steam jet compressors for heat pumps.** Hummel, W. (Wiegand Karlsruhe G.m.b.H. (Germany, F.R.)). 1976. 26p. (In German). (CONF-7606121—1). Dep. NTIS (US Sales Only) $4.00.

From Seminar on the use of heat pumps in industry for heat recovery; Essen, German, Federal Republic of (F.R. Germany) (29 Jun 1976).

When using steam jet compressors for heat pumps, their design should be suitable for all operating conditions. The lower the compression ratio and the higher the expansion ratio (the ratio of driving pressure/suction pressure) the less driving steam is required, and the vacuum is, therefore, the main field of application. A high expansion ratio is also achieved with high-pressure driving steam, and steam jet compressors are, therefore, used also as heat pumps in the excess pressure region. The rentability may be increased by multistage operation. The main feature of steam jet compressors is their relatively simple design without moving parts. They can, therefore, be constructed from the most diverse materials. Corrosion resistance is no problem, and maintenance is unnecessary since there are no moving parts. They are extremely easy to operate: all the operator has to do is to open or close the steam valve. Sometimes an additional isolating valve is required on the suction side.

54729 (AED-Conf—76-285-001) **Operational experience and examples of existing heat pump plants.** Vielhaber, K. (Bosch (R.) G.m.b.H., Wernau/Neckar (Germany, F.R.)). 1976. 18p. (In German). (CONF-7606121—2). Dep. NTIS (US Sales Only) $3.50.

From Seminar on the use of heat pumps in industry for heat recovery; Essen, German, Federal Republic of (F.R. Germany) (29 Jun 1976).

The suitability of different heating systems for heat pump operation and their influence on the mean thermal efficiency are discussed. The possible applications of bivalent heat pump heatings are illustrated by the example of existing plants. The operation of an air—water heat pump with auxiliary liquefied-gas heating is explained with the aid of temperature diagrams and monthly supply measurements. Measurements on a water—water heat pump with indirectly heated water storage device confirm the suitability of heat pumps for heating industrial water and their economy as compared with oil combination boilers.

54730 (PB—265491) **Identifying retrofit projects for buildings.** (JRB Associates, Inc., McLean, Va. (USA)). Sep 1976. Contract FEA-CO-04-60483-00. 116p. NTIS, PC A06/MF A01.

This handbook was prepared to assist building and facility managers throughout the Federal Government in identifying early payoff retrofit opportunities. The method can be used to identify retrofit options without a costly survey by an architectural and engineering firm. The handbook presents a tool for people at a facility to use in identifying potential retrofit options and preparing preliminary cost estimates for these options.

54731 District heating pipe, particularly for hot water pipes. Nilsson, E.; Lundbohm, L. (to Nyby Bruk AB, Nybybruk (Sweden)). German(FRG) Patent 2,219,228/C/. 18 Nov 1976. 4p. (In German).

The invention concerns a district heating channel with one or more pipes in which the heating medium flows. The pipes are surrounded by insulating material, which is covered with water tight sheet at the top and at the sides. The sheet is provided with holes, which permit steam to pass through. This arrangement ensures that the district heating channel or the insulation itself dry out after the ingress of large quantities of water.

54732 Present and future of district heating and cooling in Hamburg. Dommann, D. (Hamburgische Electricitaets-Werke A.G. (Germany, F.R.)). *Energie;* **29**: No. 2, 23-31(Feb 1977). (In German).

For several decades, Hamburger Elektrizitaetswerke AG (HEW) have operated a wide district heating network according ot the principle of heat-power coupling. The article deals with the present state of HEW district heating, the existing hot-water network, developmentes in the sales of district heat for town heating and industry, the potential demand in case of free competition and the technical possibilities of satisfying his demand with the existing production and distribution plants and meeting further potential demands by erecting new generation plants. A cost comparison on the basis of coke, oil, gas and distric heat was made for a single-family house. The 2nd part deals with the practice of district cooling in general and with the technical state of the district cooling plant 'City Nord' in particular. The development of the technical data and the cost of district cooling from 1972 to 1976 are shown in a table.

54733 What is a heat pump. McMullan, J.T.; Morgan, R.; Murray, R.B. (Ulster Univ., Coleraine (UK). School of Physical Sciences). *Arch. Energiewirtsch.;* 31: No. 3, 240-245(Mar 1977). (In German).

3 figs. Translated from English. Also published in Electr. Riv. (May 1976) v. 198(16) p. 24-25.

Starting from the discrepancy between theoretical and practical efficiency, some measures to raise the practical efficiency are discussed. Also, waste heat utilization is shortly discussed.

RESIDENTIAL

54734 (PB—265717) Energy efficiency program for appliances. (Midwest Research Inst., Kansas City, Mo. (USA)). Feb 1977. Contract FEA-CR-04-60664-00. 85p. NTIS, PC A05/MF A01.

The main objective of this study is to identify candidate consumer products to be covered by the 14th category of household consumer products outlined by P.L. 94-163 (Part B, Title V) – The Energy Policy and Conservation Act of 1975. Alternative definitions for household are reviewed. The potential consequences of alternative definitions for household are examined. Tables within the report itemize published annual energy consumption estimates from seven prior surveys and summarize consumer use patterns (hour/year) and power ratings (wattage) derived from MRI research.

SCHOOL

REFER ALSO TO CITATION(S) 54677

COMMERCIAL

REFER ALSO TO CITATION(S) 54682

TRANSPORTATION AND PROPULSION

REFER ALSO TO CITATION(S) 54666

AIR AND AEROSPACE

REFER ALSO TO CITATION(S) 54708

54735 (N—77—17037) Oblique wing transonic transport configuration development. Final report. (Boeing Commercial Airplane Co., Seattle, Wash. (USA). Dept. of Preliminary Design). Jan 1977. Contract NAS2-7031. 162p. (NASA-CR—151928). NTIS, PC A08/MF A01.

Studies of transport aircraft designed for boom-free supersonic flight show the variable sweep oblique wing to be the most efficient configuration for flight at low supersonic speeds. Use of this concept leads to a configuration that is lighter, quieter, and more fuel efficient than symmetric aircraft designed for the same mission. Aerodynamic structural, weight, aeroelastic and flight control studies show the oblique wing concept to be technically feasible. Investigations are reported for wing planform and thickness, pivot design and weight estimation, engine cycle (bypass ratio), and climb, descent and reserve fuel. Results are incorporated into a final configuration. Performance, weight, and balance characteristics are evaluated. Flight control requirements are reviewed, and areas in which further research is needed are identified.

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 54661

54736 (PB—265812) Evaluation report on the Santa Monica Freeway Diamond Lane project after 21 weeks of operation. Final report Mar-Aug 76. (California State Dept. of Transportation, Sacramento (USA)). Sep 1976. 44p. NTIS, PC A03/MF A01.

The report contains analysis and findings developed from information gathered by Caltrans during the 21 weeks of operation of the Santa Monica Diamond Lanes. The Diamond Lane project had reserved the fast lanes of a 12.5 mile segment of the Santa Monica Freeway in Los Angeles, from Lincoln Boulevard to the Harbor Freeway for bus and carpool use. Its objective was to conserve energy and improve air quality, and to demonstrate that more efficient use could be made of existing transportation facilities without a massive new investment in freeways. The report analyzes the results of the Santa Monica Diamond Lanes. It identifies the user characteristics of the freeway. It reports on the travel conditions of the freeway. It discusses traffic diversion. It presents the effects of the project on energy, air quality, safety and costs and benefits.

54737 (PB—265821) Study of future paratransit requirements. Executive summary. (Voorhees (Alan M.) and Associates, Inc., McLean, Va. (USA)). Feb 1977. 27p. NTIS, PC A03/MF A01.

Prepared in cooperation with Battelle Columbus Labs., Ohio. See also report dated Nov 76, PB-262 629.

The overall objective of this study is to define the future dimensions and characteristics of paratransit and the requirements for testing innovative transportation services for the development of new vehicles, and for ways to overcome legal and institutional constraints. The analysis is based on urban scenarios projected into the 1980-1995 time frame and representative of a large number of locations. This Executive Summary report examines a range of paratransit service concepts in context with a set of typical urban settings under three alternative 1995 futures. These alternative futures are described in terms of energy cost and degree of automobile disincentives. Integrated transit and paratransit systems are defined and match a combination of transit and paratransit services with forecasted transportation needs for each individual setting.

54738 (PB—265875) Freeways, automatic vehicle identification, and effects of geometrics. Transportation research record. Fambro, D.B. (Transportation Research Board, Washington, D.C. (USA)). 1976. 92p. (TRB-TRR—601).

The 17 papers in this report deal with the following areas: Cost effectiveness of freeway courtesy patrols in Houston; urban freeway corridor control model; single point diversion of freeway traffic; operating parameters for main-line sensors in freeway surveillance systems; developments in automatic vehicle identification during 1974 and 1975; an approach for maximizing the capacity of self-service parking facilities; planning transit facility parking for the Boston metropolitan area; framework for design and operation of passing zones on two-lane highways; roadside encroachment parameters for nonfreeway facilities; effect of the energy crisis on existing design standards; roadside hazards on nonfreeway facilities; effect of commercial vehicles on delay at intersections; evaluation of factors influencing driveway accidents; effect of bridge shoulder width on traffic operational characteristics; effect of guardrails on interstate bridges on vehicle speed and lateral placement; characteristics of intersection accidents in rural municipalities; and highway accidents at bridges.

54739 Attitudinal travel demand model for non-work trips of homogeneously constrained segments of a population. Recker, W.W.; Stevens, R.F. (State Univ. of New York, Buffalo). *Transp. Res.;* 11: No. 3, 167-176(Jun 1977).

Market-segmentation techniques are used to capture effects of opportunity and availability constraints on urban residents' choice of mode for trips for major grocery shopping and for visiting friends and acquaintances. Attitudinal multinomial logit choice models are estimated for each market segment. Explanatory variables are individual's beliefs about attributes of four modal alternatives: bus, car, taxi and walking. Factor analysis is employed to identify latent dimensions of perception of the modal alternatives and to eliminate problems of multicollinearity in model estimation.

PIPELINE

REFER ALSO TO CITATION(S) 54699

INDUSTRY

ENERGY SOURCES

REFER ALSO TO CITATION(S) 54682

EQUIPMENT AND PROCESSES

54740 (PB—265712) Agricultural energy requirements and land use patterns in Illinois. Report for 1974. Ruthenburg, K.; Dunwoody, J.E. (Illinois Dept. of Business and Economic Development, Springfield (USA). Div. of Energy). Aug 1976. 73p. (ILLDOE—76/06). NTIS, PC A04/MF A01.

The Illinois Division of Energy undertook an evaluation of the energy impact of remaining agricultural production caused by withdrawing land from agricultural production. An assessment was made on the energy impact in terms of the additional energy needed

to produce more corn and soybeans on less area of land. Both direct and indirect energy impacts have been assessed.

54741 (PB—265713) **Measuring and improving the efficiency of boilers. A manual for determining energy conservation in steam generating power plants. Final report.** (Auburn Univ., Ala. (USA). Engineering Extension Service). Nov 1976. Contract FEA-CO-04-50100-00. 183p. NTIS, PC A09/MF A01.

The study includes introductory material on the energy situation, a description of boilers and factors affecting boiler efficiency, a complete test program for determining efficiency and factors causing poor performance, a presentation of economics associated with energy conservation, proper methods for controlling boiler load, air-fuel ratio and feedwater chemistry, various capital expenditures for the recovery of waste heat from boilers, and a description of the operation and maintenance of boilers.

54742 (PB—265764) **Identification of major areas of energy utilization in the food processing/foodservice industry.** Dwyer, S.J. III; Unklesbay, K.; Unklesbay, N.; Dunlap, C. (Missouri Univ., Columbia (USA)). Jan 1977. 400p. NTIS, PC A17/MF A01.

Three main research objectives were: (1) to determine methods for increasing the ratio of the amount of food produced to the amount of energy expended; (2) to determine areas in which further research will lead to better energy utilization; and (3) to identify the effects of food laws and regulations upon energy utilization. The report includes the following topics: energy accounting models developed for the direct processes and for transportation; an application of the energy accounting model in representative chicken process industries and foodservice establishments; a review of the food laws and regulations pertaining to chicken processing, distribution and service; data analysis from the application of the energy accounting model and identification of large areas of energy utilization; a discussion of the influence of regulatory and other agencies upon energy utilization; and a presentation of areas for potential energy reductions.

WASTE HEAT UTILIZATION

54743 **Heat wheels are efficient even at oven temperatures.** Gifford, S.E. (Regenerative Heat Corp., Middletown, CT). pp 434-439 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976).

See CONF-761016—.

Engineering for waste heat utilization in industrial plants is considered. The design should be such that pressure conditions in the regenerator prevent accidental leakage of contaminated exhaust to incoming air being warmed. Methods of evaluation of possible savings are given in detail. The greatest gain can usually be made by recycling the waste heat to the process; if this is not practical, it should be used for plant heating. Certain possible factors are considered: Savings on basic equipment or fuels due to regeneration, cooling of contaminated effluents to assist in solvent recovery or pollution control; savings of cold air in the case of refrigerated systems; and recommendations for the necessary calculations in various situations. (LTN)

RECYCLING

54744 (PB—265393) **Treatment of electroplating wastes by reverse osmosis. Final report.** Donnelly, R.G.; Goldsmith, R.L.; McNulty, K.J.; Grant, D.C.; Tan, M. (American Electroplaters' Society, East Orange, N.J.). Sep 1976. 106p. NTIS, PC A06/MF A01.

Reverse osmosis treatment of plating bath rinsewaters has been examined. Emphasis has been placed on closed-loop operation with recycle of purified water for rinsing, and return of plating chemical concentrate to the bath. Three commercially available membrane configurations have been evaluated experimentally; tubular (cellulose acetate membrane), spiral-wound (cellulose acetate membrane), and hollow-fiber (polyamide membrane). Tests were conducted with nine different rinsewaters prepared by dilution of actual plating baths. Advantages and limitations of the reverse osmosis process and specific membranes and configurations are discussed. Systems tested include nickel sulfamate, Watts type nickel, copper pyrophosphate, zinc chloride, copper cyanide, zinc cyanide, cadmium cyanide, nickel fluoborate and chromic acid.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 54707, 54710, 54854, 55140

54745 (NTIS/PS—77/0330) **Incineration studies. Volume 2. 1975-April 1977 (citations from the NTIS Data Base). Report for 1975-Apr 77.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 186p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0224, NTIS/PS—75/350, and COM—73-11437. See also NTIS/PS—76/0225, and NTIS/PS—77/331.

Federally-sponsored research on incineration of municipal, industrial, and agricultural wastes is discussed. Topics cover incinerator design, air pollution control, materials recovery, heat recovery, pyrolysis incineration, and cost studies. (This updated bibliography contains 181 abstracts, 93 of which are new entries to the previous edition.)

54746 (NTIS/PS—77/0331) **Incineration studies. Volume 2. 1975-April 1977 (citations from the Engineering Index Data Base). Report for 1975-Apr 77.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 202p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0226. See also NTIS/PS—76/0223, and NTIS/PS—77/0330.

Worldwide research on the incineration of municipal, industrial, agricultural, and shipboard wastes is discussed. Topics cover incinerator design, air pollution control, materials recovery, heat recovery, pyrolysis incineration, and cost studies. (This updated bibliography contains 195 abstracts, 127 of which are new entries to the previous edition.)

54747 (NTIS/PS—77/0357) **Regional and urban solid waste disposal. Part 1. Management planning (a bibliography with abstracts). Report for 1964-May 77.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 202p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0301, NTIS/PS—75/184, NTIS/PS—74/105, and NTIS/PK—151.

Management, state and local government policies, legislation, financing, data acquisition and general planning studies for urban and regional solid waste disposal systems are covered. The topics include comments on public health, landfills, pollution, recycling and load use. Studies on energy recovery and consumption, environmental impacts, land use, guidelines and models are also covered. (This updated bibliography contains 197 abstracts, 65 of which are new entries to the previous edition.)

54748 (NTIS/PS—77/0358) **Regional and urban solid waste disposal. Part 2. Local case studies (a bibliography with abstracts). Report for 1964-May 77.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 162p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0302, and NTIS/PS—75/185.

Case studies are cited on municipal waste disposal in specific cities, counties or regions. These studies include all aspects of collection, hauling, incineration, sanitary landfills, ocean dumping and transfer stations as applied to a specific locale. Management studies designed only for these areas are also included. (This updated bibliography contains 157 abstracts, 29 of which are new entries to the previous edition.)

54749 (NTIS/PS—77/0359) **Regional and urban solid waste disposal. Part 3. Handling and disposal technology (a bibliography with abstracts). Report for 1964-May 77.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 198p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0303, and NTIS/PS—75/186.

The citations cover the technology and techniques of collection, hauling, sorting, processing, disposal, incineration and recycling of urban wastes. These abstracts were chosen to describe methods and equipment for waste handling, disposal, or reclamation. In addition studies on refuse derived fuels and energy consumption in solid waste processing are covered. (This updated bibliography contains 193 abstracts, 46 of which are new entries to the previous edition.)

54750 (PB—265232) **Water reuse in a paper reprocessing plant. Final report.** Streebin, L.E.; Reid, G.W.; Law, P.; Hogan, C. (Big Chief Roofing Co., Ardmore, Okla (USA)). Oct 1976. 95p. NTIS, PC A05/MF A01.

Prepared in cooperation with Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.

This project was undertaken to determine the feasibility of water reuse in a paper reprocessing plant with the goal being to 'close the loop' or to demonstrate zero discharge technology. Before the project began, Big Chief Roofing Company at Ardmore, OK, was discharging 7.89 l/sec (125 gpm). Normal operation is now zero discharge with approximately 0.76 l/sec (12 gpm) fresh water make-up replacing evaporative losses. However, weekly clean-ups still result in an effluent of approximately 15.14 cu m (4000 gal) a week. Additional clear water storage capacity could eliminate this weekly discharge. Project scope included identifying and solving problems resulting from increased recycle of process water, and determining

costs, benefits, and effect on product quality. The favorable cost/benefit ratio experienced at the plant demonstrated an economic advantage of in-plant control over end-of-pipe treatment. Attaining zero discharge operation has the further benefit of eliminating the problems, cost, and liabilities associated with operation under a discharge permit. Economic benefits observed during zero discharge operation included reduced water supply costs, reduced wastewater treatment costs, improved yield, improved drainage and greater dryer section production. The benefits were partially offset by shorter felt lives, increased corrosion control cost, and process modification cost. No degradation of product quality was observed.

54751 (PB—265357) **Fruit cannery waste activated sludge as a cattle feed ingredient.** Esvelt, L.A. (Snokist Growers, Yakima, Wash. (USA)). Sep 1976. 66p. NTIS, PC A04/MF A01.

Prepared by Bovay Engineers, Inc., Spokane, Wash.

The feasibility of sludge disposal from a fruit processing waste activated sludge treatment system by dewatering and using the dewatered biological sludge solids as cattle feed was evaluated by Snokist Growers at Yakima, Washington. Dewatering of the biological sludge utilizing pilot-scale and prototype-scale basket centrifuges resulted in consistently dewatering to 7-1/2% to 9% dry solids. Digestibility and metabolizability of rations containing 2.3% and 4.5% biological solids appeared equal to a control ration, but a ration containing 9.2% biological solids appeared lower. Twenty-four uniform yearling steers were divided into four lots of six each and finish fed a control ration and rations containing 2.3%, 4.6%, and 8.9% sludge solids on a dry matter basis for 165 days. They did not show any adverse effects of the sludge incorporation into their rations. It appeared that a low quantity of sludge (2.3% dry solids) actually enhanced the weight gain performance and carcass quality of these animals. The cost of a dewatering installation will require that the cannery receive remuneration for use of the waste activated sludge as cattle feed in order to make a full-scale dewatering project feasible. The calculated value of the biological solids incorporated into the rations was in the range of $0.092 to $0.148 per kg dry solids.

54752 (PB—265480) **Granulation of complex fertilizers containing ammonium sulfate by melt technology. Final report.** Lanier, J.; MacDonald, R. (Ferguson Industries, Dallas, Tex. (USA)). Dec 1976. Contract EPA-68-01-0754. 106p. NTIS, PC A06/MF A01.

A novel process was developed for production of high analysis fertilizers in which large portions of the nutrients are derived from by-product and waste ammonium sulfate. The materials produced exhibit good physical and storage characteristics and are similar in grades to those now being consumed in large quantities. Phosphoric acid and anhydrous ammonia are reacted to form the liquid bonding agent. Solid ammonium sulfate, potassium chloride and recycled fines are added to the melt in a pug mill. Emissions of pollutants is less than from conventional plants and is readily contained. The process was developed and tested on a laboratory scale and in a small pilot plant and was verified in a 454 kilogram per hour (1000 pound per hour) demonstration unit. Capital and operating cost estimates are presented. The operating cost is sensitive to the assumed value of waste ammonium sulfate. In comparison to similar grade products, cost savings of 10 to 20% can be realized if true waste values can be assumed. The financial estimates did not attempt to evaluate the indirect benefit to society, in terms of dollars and of energy, of recovering waste ammonium compounds and sulfur dioxide---which often are discarded into aquifers or into the atmosphere and thus constitute major pollutant threats---and of converting these chemicals into useful products.

54753 (PB—265578) **Household water conservation and wastewater flow reduction. Final report.** Chan, M.L.; Edwards, J.; Roberts, M.; Stedinger, R.; Wilson, L. (Energy Resources Co., Inc., Cambridge, Mass. (USA)). 1 Jul 1976. Contract EPA-68-02-2964. 168p. NTIS, PC A08/MF A01.

The legal and economic aspects of devices and policies to reduce water and wastewater flows were studied. After reviewing the literature, the report examines building and plumbing codes from selected areas to see whether or not they provide constraints on the introduction of water-saving devices; and considers state laws to see whether they permit pricing schemes which encourage conservation. A computer model is developed, using water demand functions and cost functions from the literature, to determine the benefits to consumers and producers of various pricing systems. Through use of a second computer model, benefits are calculated for various replacement strategies in the adoption of water-saving devices.

54754 (TID—27633) **Waste flow characteristics and resource recovery.** (Resource Planning Associates, Inc., Washington, D.C. (USA)). 8 Oct 1976. Contract EY-76-C-02-4011. 128p. Dep. NTIS, PC A07/MF A01.

In order to provide technical assistance for the planning, design, and optimum economic operation of solid municipal waste processing plants for materials or energy recovery, a study was made of information on solid waste flows. The quantity and quality of waste flow data is discussed, the effects of waste flows on resource recovery facilities is analyzed, and recommendations are made for government action for improving the accuracy and availability of waste flow data. (LCL)

54755 **Process development studies on the enzymatic hydrolysis of cellulose.** Wilke, C.R.; Mitra, G. (Univ. of California, Berkeley). *Biotechnol. Bioeng. Symp.;* No. 5, 253-274(1975).

This paper reports the results of several conceptual design studies on the enzymatic hydrolysis of cellulose in newsprint. This study is intended to provide perspective on the potentiality and possible goals of cellulose processing, and to serve as a guide to recognition of important cost factors. The cellulase system of Trichoderma viride QM9414 [1-3] was selected as the hydrolyzing agent. Several other laboratory studies are described, including hydrolysis rates for newsprint, solid-liquid separation, and enzyme recovery. 11 tables, 8 figs. (DLC)

54756 **Incinerator for industrial liquid wastes.** Trapp, J.H. Sr. pp 428-433 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976).

See CONF-761016—.

The design of a proposed incinerator facility for disposing of liquid industrial wastes is described. Regulations and concern for effects on sewers and on biological sewage treatment processes made it undesirable to dispose of these wastes in landfills or sewers. (LTN)

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

54757 (NTIS/PS—77/0353) **Motorcycle safety, environmental effects, and performance studies (a bibliography with abstracts). Report for 1964-Apr 77.** Adams, G.H. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 104p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0194.

The reports cited in this bibliography primarily are concerned with motorcycle safety and pollution. These studies cover safety equipment and education, visual and visibility factors, noise, fuel consumption, engine performance, air pollution, vehicle design, tire and brake characteristics, and illuminating systems. Testing programs are described for both machines and operators, underlining impact and anthropomorphic crash data. Training programs are noted for drivers. Particular attention is given to accident prevention, safety helmets, and protective clothing. (This updated bibliography contains 99 abstracts, 21 of which are new entries to the previous edition.)

ELECTRIC-POWERED SYSTEMS

54758 (AD-A—038825) **Superconducting electric machines for ship propulsion. Final technical report 1 Apr 72—31 Dec 76.** Kirtley, J.L. Jr.; Smith, J.L. Jr. (Massachusetts Inst. of Tech., Cambridge (USA). School of Engineering). 14 Feb 1977. Contracts N00014-75-C-0497;N00014-67-A-0204-0068. 79p. NTIS PCA05/MF A01.

Several superconducting ac machine concepts were studied for ship propulsion applications. These concepts evolved from previous work at MIT on superconducting ac machines. The superconducting machines considered were: (1) multipole, low-speed motors, (2) torque compensated motors, (3) high-speed generator, (4) rotating air-gap armature induction motor, (5) thyristor switched ac motors. The first four machine types were studied theoretically while experimental models were constructed of the last two. Preliminary designs were completed for each of the five mahcines for an appropriate ship propulsion application. In addition a theoretical study of the refrigeration requirements for ac superconducting machines was performed.

54759 (N—77—17947) **Results of baseline tests of the Lucas Limousine.** Soltis, R.F.; Dustin, M.O.; Sargent, N.B. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Jan 1977. 29p. (NASA-TM-X—73609; E—9075). NTIS, PC A03/MF A01.

Subm-Sponsored in Part by Erda.

The Lucas Limousine, an electric vehicle, was tested to assess the state-of-the-art of electric vehicles. All tests were made without the regenerative braking system and were conducted at the gross vehicle weight of 7,700 pounds. Over a 30 mph stop and go driving cycle the vehicle went 48.4 miles. The vehicle was able to accelerate to 30 mph in about 15 seconds with a gradeability limit of 16.5 percent. As determined by coast down tests the road power and road

energy consumption for the vehicle were 2.92 kilowatts and 0.146 kWh/mi, respectively, at 20 mph. At 40 mph the road power requirement was 11.12 kilowatts and the road energy requirement was 0.278 kWh/mi. The maximum energy economy measured 0.45 kilowatt hours per mile at 30 mph and increased to 0.76 kilowatt hours per mile at 50 mph. Over the 30 mph stop and go driving cycle the energy economy was 0.92 kilowatt hours per mile.

VEHICLE DESIGN FACTORS

BODY AND CHASSIS

54760 (NTIS/PS—77/0339) **Aerodynamic forces on motor vehicles (citations from the NTIS Data Base). Report for 1964-Mar 77.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 47p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0283. See also NTIS/PS—77/0340.

Aerodynamic lift, drag, and sideforces exerted on moving motor vehicles are investigated in these Government-sponsored research reports. Forces acting on passing vehicles as well as those acting under and around individual moving vehicles are reviewed. (This updated bibliography contains 42 abstracts, 9 of which are new entries to the previous edition.)

54761 (NTIS/PS—77/0340) **Aerodynamic forces on motor vehicles (citations from the Engineering Index Data Base). Report for 1970-Mar 77.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 90p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0284. See also NTIS/PS—77/0339.

Aerodynamic lift, drag, and sideforces exerted on moving motor vehicles are investigated in these reports gathered from worldwide literature surveys. Forces acting on passing vehicles as well as those acting under and around individual moving vehicles are reviewed. Methods for streamlining vehicle configurations for fuel conservation are suggested. (This updated bibliography contains 83 abstracts, 13 of which are new entries to the previous edition.)

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 55015, 55016

54762 **Duel fuel system for internal combustion engine.** Overton, D.L. US Patent 4,019,477. 26 Apr 1977. Filed date 16 Jul 1975. 6p.

In addition to the gasoline-air mixing primary carburetor on an internal combustion engine, an auxiliary carburetor is provided for mixing air and alcohol, to thereby provide a substantial portion of the fuel-air mixture used by the engine during idle conditions and light-load conditions, while the primary carburetor provides an increasingly greater portion of the total fuel-air mixture during high-load conditions. The alcohol fuel-air mixture flows directly to the intake manifold, thus by-passing the throttle valve which controls the fuel-air mixture from the primary carburetor. The auxiliary carburetor is vacuum controlled.

54763 **Fuel injection timing control system for internal combustion engine.** Hobo, N.; Enomoto, N.; Suzuki, Y.; Kawamoto, I.; Iyoda, M.; Tsuzuki, Y.; Sekino, K.; Nukata, H. (to Nippondenso Co., Ltd.). US Patent 4.019,478. 26 Apr 1977. Filed date 12 Sep 1975. 10p.

A fuel injection timing control system is described. A fluid actuator having a fluid chamber contains a movable wall member, and the amount of pressure medium in the fluid chamber are controlled by electromagnetically operated control valve means to cause the actuator to operate an element for controlling the fuel injection timing of a fuel injection pump. In the control system, a control voltage is produced from at least a speed signal corresponding to the rotational speed of an engine and a fuel injection quantity signal corresponding to the amount of fuel injected into the engine from a fuel injection pump, and this control voltage is compared with a injection timing voltage corresponding to the fuel injection timing of the fuel injection pump to produce a deviation signal which is used to actuate the electromagnetically operated control valve means so as to automatically control the fuel injection timing of the injection pump and thereby to obtain the optimum injection timing that suits the varying operating conditions of the engine.

54764 **Apparatus for modifying an internal combustion engine.** Garabedian, A. US Patent 4,019,479. 26 Apr 1977. Filed date 6 Sep 1974. 12p.

A device is described for splitting the operation of a multicylinder internal combustion engine to allow the use of one group of the cylinders during a first phase of operation and the use of both the first and second group of the cylinders during a second phase of operation. In the first phase of operation all fuel and air is blocked by a throttle valve from entering the inactive second group of cylinders, causing these cylinders to operate in a vacuum environment. The throttle controlling the second group of cylinders operates in response to the operation of a throttle controlling the first group of cylinders. In an alternative embodiment, the throttle of the second group of cylinders is kept slightly open during the first phase of operation to provide just enough fuel and air to the second group of cylinders to provide power to turn the pistons in the second group of cylinders and reduce the potential drag forces to the active first group of cylinders.

54765 **Fuel injection systems.** Lakra, P. (to C.A.V. Ltd.). US Patent 4,019,481. 26 Apr 1977. Priority date 7 Mar 1975, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

A fuel injection system includes a piston movable within a bore to displace fuel through a fuel outlet. Fluid under pressure can be admitted to the other end of the bore by way of a valve means to effect movement of the piston to displace fuel and when the valve means is closed a further valve means can be opened to permit the piston to move in the opposite direction. The valve means and the further valve means are actuated by a control pressure generated by a stack of piezo-electric crystals. The valve means includes a plurality of pressure balanced pistons and when the stack of crystals is de-energized the valve means is in the closed position.

54766 **Fuel separator.** Pugliese, R.J. US Patent 4,019,482. 26 Apr 1977. Filed date 5 Feb 1976. 6p.

A fuel separating device is adapted to be connected between a carburetor and the intake manifold or integrally built into the intake manifold of an internal-combustion engine for removing excess fuel from the fuel-air mixture provided by the carburetor. The device comprises a housing having upper and lower chambers that are separated by a plate having a plurality of upright tubular members which communicate the upper chamber to the lower chamber. The device has an inlet port communicating the upper chamber to the outlet of the carburetor and an outlet port which communicates the lower chamber to the inlet of the manifold such that a fuel flow passage is provided for directing the fuel-air mixture from the carburetor to the manifold, while excess fuel droplets carried by the mixture are deposited at the bottom of the upper chamber. Means are provided for drawing off the excess fuel and returning it to the fuel supply tank.

54767 **Fuel system for multicylinder engines.** Konomi, T.; Nurita, J.; Masuda, T. (to Toyota Jidosha Kogyo Kabushiki Kaisha). US Patent 4,019,483. 26 Apr 1977. Priority date 7 Nov 1973, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

In a multicylinder internal combustion engine a cylindrical member is located downstream of a carburetor, with the cylindrical member disposed parallel to a vaporizing barrel of the carburetor and arranged downstream of the vaporizing barrel. A deflector plate for changing the stream of a fuel-air mixture is provided at a downstream position of the cylindrical member. Further, a cylindrical member with a deflector plate is disposed in the downstream of the primary vaporizing barrel of a duplex carburetor, and a cylindrical member with a slant port is disposed downstream of the secondary vaporizing barrel.

54768 **Motor ignition system with magnetically selectable gas discharge devices.** Siegle, G. (to Robert Bosch GmbH). US Patent 4,019,486. 26 Apr 1977. Priority date 16 Nov 1973, German, Federal Republic of (F.R. Germany). 8p.

A magnetic field, such as produced by a surrounding coil, lowers the breakdown voltage of a gas discharge device in series with a spark plug so that the ignition voltage with preferentially go to that spark plug rather than to others in series with gas discharge devices having no magnetic field. The switching of the field-producing coils of the gas discharge devices in accordance with the firing cycle of an engine may be produced by a transistor switching circuit excited by a simple rotary electric timing device that also times the spark pulses. A gas discharge device for this system is shown having an elongated cup-shaped anode and rodlike cathode, which can also be made to serve as the sealing tube, centered within the anode. Gas discharge devices for this system are shown in U.S. Pat. No. 3,951,144 to the same assignee.

EMISSION CONTROL

54769 **Catalytic reactor for automobile.** Vroman, W.R. (to Chrysler Corp.). US Patent 4,020,539. 3 May 1977. Filed date 24 Mar 1975. 8p.

A catalytic reactor of oval cross section consists of a generally cylindrical catalytic substrate clamped between paired housing shells and spaced from them by a mesh support that extends around the oval periphery of the substrate and slightly overlaps the latter's axially opposite end to provide locating projections. The support and housing are preferably interlocked by one or more pairs of

inwardly opening channels of the housing having portions of the mesh support confined inside, each pair being spaced axially by a rib of the housing projecting into the mesh support. The housing has axially endwise converging cam portions adjacent and axially endwise of the opposite ends of the substrate to engage the locating projections and center the assembled substrate and mesh support within the housing during manufacture of the reactor.

NITROGEN OXIDES

54770 Catalytic composite for treating exhaust gases from an internal combustion engine. Brennan, J.F. (to UOP Inc.). US Patent 4,020,013. 26 Apr 1977. Filed date 20 Oct 1975. 4p.

A catalytic composite of a high surface area refractory inorganic oxide containing rhodium and ruthenium impregnated on it in a weight ratio of from about 1:1 to about 2 : 1. The rhodium comprises from about 0.02 to about 0.10 wt. % of the catalytic composite. The catalytic composite is particularly useful in the treatment of exhaust gases to convert nitrogen oxides to nitrogen.

HYDROCARBONS

REFER ALSO TO CITATION(S) 54766

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 54762

MATERIALS

REFER ALSO TO CITATION(S) 53605

METALS AND ALLOYS

54771 (ORNL—5270) **Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending December 31, 1976.** Peterson, S. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Apr 1977. Contract W-7405-ENG-26. 225p. .

The five sections of this report are abstracted separately. (GHT)

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 53946, 54029, 54789, 54832

54772 (AD-A—038354) **Development of a production process for large cylinders from mixtures of spherical powders of high strength titanium alloys and beryllium. Final report for program II.** Loewenstein, P. (Whittaker Corp., West Concord, Mass. (USA). Nuclear Metals Div.). Aug 1971. Contract DAAG46-71-C-0076. 36p. (NM—2400.2). NTIS, PC A03/MF A01.

Microquenched spherical powders of Ti-6Al-6V-2Sn and of beryllium were produced by the Rotating Electrode Process. Two approaches were used in order to develop a fabrication process for 6-inch od x 1/2-inch wall tubular shells, from the titanium alloy as well as from a mixture of 90v/oTi alloy with 10v/oBe. The first approach, which proved unsuitable, consisted of a consolidation-upset-forging-cupping sequence. The second approach consisted of a direct single step extrusion in copper cans. It was shown that a minimum reduction in area of 6:1 is required to obtain sound structures and high strength. Two billets for the production of full size tubular shells were prepared.

54773 (AD-A—038848) **Warm-die-forming of beta titanium alloy strip. Final report.** Arnold, S.V.; Doyle, P.J. (Army Materials and Mechanics Research Center, Watertown, Mass. (USA)). Dec 1976. 24p. (AMMRC-TR—76-41). NTIS PCA02/MF A01.

Continuous strip of Ti-8Mo-8V-2Fe-3Al was investigated for possible application in the nose cap for the main rotor blade of the Heavy Lift Helicopter as part of the Advanced Technology Component Program. Aging response of strip solutionized in a continuous vacuum annealing furnace and subsequently cold rolled was determined as functions of time and temperature for several levels of cold reduction. Tensile and fatigue properties of strip produced by selected practices were measured. Feasibility of creep forming solutionized-and-cold-rolled strip to nose cap contours during aging was explored. Warm die forming and aging of strip to those same contours was demonstraied.

54774 (LA-UR—77-397) **Use of a microcomputer-based data acquisition system to improve process control in an electron beam welding machine.** Casey, H.; Flick, F.; Vigil, V. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 18p. (CONF-770311—1). Dep. NTIS, PC A02/MF A01.

From WESTEC 77 conference; Los Angeles, California, United States of America (USA) (14 Mar 1977).

As part of a program to upgrade electron beam welding equipment, a micro-computer-based data acquisition system has been built and interfaced with a Hamilton Standard W-2 machine. This presentation will review the design and performance of the system. The practical application of this and similar systems for improved process control will be discussed. Data will be presented relating to the significance of process parameter variations (as monitored by the data acquisition system) on weld geometry and the occurrence of weld defects.

54775 (ORNL—5270, pp 1-86) **Steam generator materials development.** Apr 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending December 31, 1976.

Topics covered include: steam-side/water-side corrosion—the corrosion of vacuum-arc-remelted 2¼ Cr-1 Mo steel by superheated steam; weldability; mechanical properties—creep and rupture behavior, heat-to-heat variation, thermal aging effects, the effect of sodium, and interim analysis of the creep strain-time characteristics of annealed and isothermally annealed 2¼ Cr-1 Mo steel; and nondestructive testing. 41 figs, 13 tables, 50 refs. (GHT)

54776 (ORNL—5270, pp 127-149) **Joining technology development.** Goodwin, G.M.; Brinkman, C.R. Apr 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending December 31, 1976.

Joining technology development is covered. Topics covered include: welding development and mechanical testing of weldments for stainless steel components; high-temperature structural design data for austenitic stainless steel weldments; hardfacing development for valves and bearings; and basic welding and brazing research, phase behavior of 16-8-2 welds. 11 figs, 8 tables, 9 refs. (GHT)

54777 (ORNL—5270, pp 151-201) **Piping and fitting development.** Goodwin, G.M. Apr 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending December 31, 1976.

Fabrication methods for producing large diameter (0.9-1.3 m) thin wall (13 mm) austenitic stainless steel piping and fittings for LMFBR primary and secondary sodium loop applications are discussed. Rolled-and-welded pipe, centrifugally cast-and-worked pipe, and welded-and-worked pipe are covered. Fittings, including clamshell forged-and-welded elbow, and continuously hot-zone-bent elbow are also covered. 30 figs, 6 tables, 25 refs. (GHT)

54778 (ORNL/TM—5741) **Importance of billet microstructure in the hot extrusion of 2% Ti-Hastelloy N.** Braski, D.N.; McDonald, R.E. (Oak Ridge National Lab., Tenn. (USA)). May 1977. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A03/MF A01.

The successful hot extrusion of billets of Ti-Hastelloy N (13 percent Mo, 7 percent Cr, 2 percent Ti, 0.06 percent C, 87.94 percent Ni) into tube shells and followed by cold drawing into 19-mm-OD (0.75-in.) tubing depends largely on the billet microstructure. It was imperative that the preheat annealing treatment given directly before hot extrusion be designed to uniformly dissolve most of the MC-type carbide particles. A 101.6-mm-diam x 304.8-mm-long (4 x 12-in.) billet required a preheat of 4 hr at 1533°K.

54779 Preparation of eutectic superalloys by EFG. Hurely, G.F.; Marr, N.W. (Mobil Tyco Solar Energy Corp., Waltham, MA). pp 263-272 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

A program to establish the feasibility of producing airfoil-shaped bars of eutectic superalloys by means of the edge-defined, film-fed growth (EFG) method was carried out. Three alloys, γ + delta, γ/γ' + delta, and a Co-TaC alloy containing Ni and Cr, were selected for the investigation. These eutectic alloys, in contrast to those previously grown by this method, were reactive toward known die materials so that development of a new die material was an essential task in the investigation.

54780 Concentration of interstitial elements on the lamination surface of sheet molybdenum. Burmaka, L.S.; Ivashchenko, Y.N.; Kostyuchenko, V.G.; Mil'man, Y.V.; Rachek, A.P.; Trefilov, V.I.; Cherepin, V.T. (Institute of Materials Science Problems). *Sov. Phys. - Dokl. (Engl. Transl.);* **22**: No. 1, 41-43(Jan 1977).

The molybdenum alloy MT and other molybdenum alloys containing small quantities of additive elements were studied after various forms of rolling reduction and heat treatment. Auger elec-

tron spectroscopy, as well as ion microscopy, was used to determine the impurity depth-distribution curves.(AIP).

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 54903

54781 (BNL—22435) **Phase diagram information for processing of superconductors.** Dew-Hughes, D. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 8p. (CONF-770116—5). Dep. NTIS, PC A02/MF A01.

From Workshop on application of phase diagrams in metallurgy and ceramics; Gaithersburg, Maryland, United States of America (USA) (10 Jan 1977).

Composition of various superconducting compounds with potentially high critical temperature (greater than 20K) is discussed. Phase diagrams of Nb—Al—Ge, Nb—Sn—Cu, and Nb—Ge—Cu are given. (GHT)

54782 (LBL—5401) **Nickel-free Fe-12Mn-0.2Ti alloy steel for cryogenic applications.** Hwang, S.; Jin, S.; Morris, J.W. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1976. Contract W-7405-ENG-48. 11p. (CONF-760804—9). Dep. NTIS, PC A02/MF A01.

From 4. international conference on strength of metals and alloys; Nancy, France (30 Aug 1976).

A nickel-free Fe-12 Mn-0.2 Ti alloy steel was investigated for cryogenic applications. The systematic control of the grain size and the microstructural distribution of the retained γ phase was made through $\alpha + \gamma$ heat treatments in combination with mechanical working. Substantial improvements of important low temperature mechanical properties were obtained by these processings. Our results indicated a good possibility of developing a new, inexpensive cryogenic steel.

54783 Resistance of a directionally solidified gamma/gamma prime-delta eutectic alloy to recrystallization. Tewari, S.N.; Scheuermann, C.M.; Andrews, C.W. (Lewis Research Center, Cleveland). pp 191-200 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

A lamellar nickel-base directionally-solidified eutectic gamma/gamma prime-delta alloy has potential as an advanced gas turbine blade material. The microstructural stability of this alloy was investigated. Specimens were plastically deformed by uniform compression or Brinell indentation, then annealed between 750 and 1120 C. Microstructural changes observed after annealing included gamma prime coarsening, pinch-off and spheroidization of delta lamellae, and appearance of an unidentified blocky phase in surface layers. All but the first of these was localized in severely deformed regions, suggesting that microstructural instability may not be a serious problem in the use of this alloy.

54784 Effect of thermal cycling in a Mach 0.3 burner rig on properties and structure of directionally solidified γ/γ'-δ eutectic. Gray, H.R.; Sanders, W.A. (Lewis Research Center, Cleveland). pp 201-210 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

Tensile and stress rupture properties at 1040°C of thermally cycled material were essentially equivalent to as-grown properties. The tensile ductility and rupture ductility at 760°C of thermally cycled γ/γ' - delta were also essentially equivalent to as-grown ductilities. The tensile strength at 760°C was about 8 percent lower than that determined for as-grown γ/γ' - delta. The rupture life at 760°C appeared to have been slightly decreased by thermal cycling, although the scatter for as-grown specimens prevented a firm conclusion that thermal cycling is detrimental. Thermal cycling resulted in gamma prime coarsening and Widmanstatten delta precipitation in the gamma phase. An unidentified precipitate, presumably gamma prime, was observed within the delta phase. The alloy exhibited a high oxidation-erosion weight loss rate during thermal cycling in the Mach 0.3 burner rig.

54785 Effect of temperature cycling under load on time to rupture in tantalum carbide reinforced superalloys. Woodford, D.A. pp 211-221 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

Results are reported on the effect of temperature cycling on rupture strength of two representative fiber strengthened eutectic composites and several non-composite superalloys. The tests mainly involved temperature cycling under load although no qualitative differences were detected between these tests and those involving prior cycling and subsequent rupture. The period of the cycle was identified as an important parameter and, for nickel base eutectic, NiTaC-13, there appeared to be a critical period for maximum degradation. An initial increase in strength and subsequent decrease with temperature cycling observed in this alloy and a cobalt base eutectic is explained in terms of a competition between deformation enhanced precipitate coarsening or recovery processes and initial strain hardening. The cyclic deformation necessary to promote this behavior may arise from the thermal expansion mismatch between matrix and fibers as in fibrous composites, or may be caused by bulk strains resulting from differential temperatures through the thickness when the material is rapidly heated and cooled down. Thus, conventional superalloys subjected to repeated thermal shocks, may show a similar response.

54786 Structure and thermal cycling stability of a hafnium monocarbide reinforced directionally solidified cobalt-base eutectic alloy. Kim, Y.G. (Lewis Research Center, Cleveland). pp 223-232 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

A nominal composition of Co-15Cr-20Ni-10.5 Hf-0.7 C ("NASA-HAFCO-11") was directionally solidified at 0.8 cm/hr growth rate to produce aligned HfC in a cobalt matrix alloy. The aligned HfC fibers were present as rod and plate types. The diameter of the aligned fibers was about 1 micron, with volume fraction in the range of 11 to 15 percent. The growth direction of the fibers was parallel to the [100]. The NASA-HAFCO-11 alloy was subjected to thermal cycling between 425° and 1100°C, using a 2.5 minute cycle. No microstructural degradation of the HfC fibers in the alloy was observed after 2500 cycles.

54787 Segregation in a plane front solidified γ/γ'-MC alloy. Gigliotti, M.F.X.; Henry, M.F. (General Electric Co., Schenectady, NY). pp 253-261 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

Plane front solidified γ/γ'-MC alloys exhibit long-range variations in composition along the growth direction (segregation). This chemical segregation was found to be due to 'normal freezing," a slow growth rate allowing complete mixing in the liquid, and the alloy having a freezing range. As such, it is not unique to γ/γ'-MC alloys, but occurs in any in situ composite alloy system that has a freezing range. Since the "eutectic trough" in 9-element space is a function of matrix alloy composition, segregation of the matrix alloy causes variations in the amount of MC reinforcing phase. The eutectic and matrix alloy variations were identical and could be fit to Pfann's analysis of normal freezing. Stress rupture properties are affected by segregation, with the stress rupture life of high-fraction solidified specimens less than that of low-fraction solidified specimens. However, recognizing that each position in an ingot is essentially a unique alloy, families of Larson-Miller curves can be generated for various values of g, each curve having little scatter in the data.

54788 Effect of alloy additions and solidification rate on structures and properties of cobalt base-TaC eutectics. Walter, J.L. pp 273-283 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

The elements Ni, Cr, and W were added to the eutectic Co-20 wt% TaC to determine their effect on maximum rate of solidification, ingot structures, TaC morphology, and stress rupture properties. Increasing Cr from 0 to 5% caused a transition from [111] oriented trifoils in the ColONi-20TaC alloy to [110] oriented blades to [100] oriented whiskers in the CoNi(5Cr)-20TaC alloy. Addition of W also caused the transition from trifoils to whiskers. Transitions from trifoils to blades and from blades to whiskers also occurred as a function of solidification rate in alloys with less than 5% Cr. Both elements increase the freezing range of the eutectic alloys and thereby decrease the maximum solidification rate at which cells form. The increase in ΔT is much less for W than for Cr. The combination of high W and solidification rates above 0.64 cm/hr produce the greatest stress rupture life. At a solidification rate of 2.5 cm/hr, the eutectic alloy ColONi20W-20TaC had a stress rupture life exceeding 2500 hrs at 1066°C and 172.3 MN/m^2, 100 times that of the highest Cr alloy solidified at 0.64 cm/hr, its maximum rate. For maximum solidification rate and maximum strength, only elements like W, that do not increase the freezing range, should be added to the CoNi-20TaC eutectic.

54789 Modification of fibrous morphology in the Cd—$CuCd_3$ and Mg—Mg_2Si eutectics by ternary additions. Haour, G. (Geneva Research Center); Rutter, J.W. pp 319-326 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

A study of the microstructural changes caused by ternary additions to two directionally solidified eutectics, Cd-$CuCd_3$ and Mg-Mg_2Si, was carried out using the technique of selective sublimation to reveal the eutectic morphology. The mechanism by which the observed modification of the eutectic structure occurs is thought to be the same in both systems studied. By electron microprobe analysis, it was found that the third component, Zn or Pb, was present with much larger concentrations in the intermetallic phase than in the matrix phase. Thus, the third component is preferentially rejected by the matrix phase during freezing and the liquid adjacent to the matrix phase may become undercooled as a result. Branching of fibers and formation of plates are believed to be responses to this undercooling. The presence of some branched rods and plates in Mg-Mg_2Si specimens without ternary additions is thought to be due to residual amounts (0.02 weight percent maximum) of lead present in the starting materials. The occurrence of a fiber to plate modification with the addition of a suitable ternary component in the eutectic systems studied indicates that some degree of control over the microstructure of such eutectics is possible with suitable alloying.

54790 Structural perfection of directionally solidified lamellar eutectics. Attallah, T.; Gurzleski, J.E. (McGill Univ., Montreal). pp 327-339 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

The mechanisms for the formation of faults in lamellar eutectics are reviewed, and it is postulated that faults play several roles in eutectic freezing with their exact importance depending on the specific alloy system and the growth conditions. Faults are not the cause of lamellar spiralling although they are necessary for it to occur. Lamellar spiralling is found to occur only when the crystallographic orientations of the two eutectic phases lead to a growth component normal to the lamellar plane, and although some systems such as Pb-Sn normally spiral it is possible for them to achieve orientation relationships where no spiralling occurs.

54791 Self-consistent theory of steady-state lamellar solidification in binary eutectic systems. Nash, G.E.; Glicksman, M.E. (Naval Research Lab., Washington, DC). pp 341-352 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

The potential theoretic methods developed recently at NRL for solving the diffusion equation are applied to the free-boundary problem describing lamellar eutectic solidification. Using these techniques, the original boundary value problem is reduced to a set of coupled integro-differential equations for the shape of the solid/liquid interface and various quantities defined on the interface. The behavior of the solutions is discussed in a qualitative fashion, leading to some interesting inferences regarding the nature of the eutectic solidification process. Using the information obtained from the analysis referred to above, an approximate theory of the lamellar-rod transition is formulated. The predictions of the theory are shown to be in qualitative agreement with experimental observations of this transition. In addition, a simplified version of the general integro-differential equations is developed and is used to assess the effect of interface curvature on the interfacial solute concentrations, and to check the new theory for consistency with experiment.

54792 Structure and superconducting properties of some lamellar eutectic alloys. Favier, J.J. (Centre des Materiaux de l'Ecole des Mines, Paris); Turpin, M.; Dupart, J.M.; Baixeras, J.; Petipas, G.; Labulle, B. pp 415-424 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

Certain properties of lamellar eutectics of regular structure have been studied. The following three systems Pb-Sn, In_2Bi-In and $AuSn_4$-Sn were chosen. The samples, which were solidified in the form of bars ($AuSn_4$-Sn) or in the form of ribbons of around 20 μm thick (Pb-Sn and In_2Bi-In) contained fault-free zones of between 50 to 100 lamellae. Monograin samples of Pb-Sn (with a diameter of 5 to 10mm) have also been fabricated in order that magnetization measurements with respect to the temperature and the applied field could be made. The crystallographic orientation relationships between Pb and Sn in the ribbons of Pb-Sn have been determined: also those for In_2Bi in the ribbons of In_2Bi-Tn(Bi). For Pb-Sn, they are different to those generally found in bulk samples.

54793 Structures and thermoelectrical properties of directionally solidified Au—PbTe eutectic. Djerassi, H. (CEN, Saclay, France); Beauvais, G.; Lesoult, G.; Racek, R.; Fortier, D.; Turpin, M.; Albany, H.J. pp 441-449 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

A composite material of gold and lead-telluride has been prepared by unidirectional solidification of a pseudo binary eutectic mixture. The eutectic microstructure consists of an hexagonal array of gold fibres in a PbTe matrix. The interfibre spacing lambda has been controlled over the range, 1.6 to 8 μm. The thermoelectric power α, the Hall coefficient R/sub H/ and the electrical resistivity rho have been measured for various interfibre spacings over the temperature range, 8 and 300 K. They are found to be dependent on the spacing lambda.

54794 Phase transitions under shock-wave loading. Duvall, G.E.; Graham, R.A. (Washington State University, Pullman, Washington). *Rev. Mod. Phys.;* 49: No. 3, 523-579(Jul 1977).

First-order polymorphic, second-order, melting, and freezing transitions induced by shock-wave loading are reviewed. Comprehensive tabulations of the experimental observations are presented and materials that have been subjected to in-depth study are reviewed in more detail. Theories of the mechanics, thermodynamics, kinetics, and shear strength of shock-loaded materials are described and experimental techniques are briefly reviewed.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 53946, 54441, 54480, 54481, 54482, 54568, 54775, 54782, 54785

54795 (AD-A—038332) **Research toward developing an understanding of crystallographic texture on mechanical properties of titanium alloys. Final technical report Jun 74-Aug 76.** Sommer, A.W.; Creager, M. (Del West Associates, Inc., Woodland Hills, Calif. (USA)). Jan 1977. Contract F33615-74-C-5107. 226p. NTIS, PC A11/MF A01.

Research was conducted during this effort to define the relationship(s) between mechanical properties and crystallographic texture development in three commonly used alpha + gamma Ti alloy compositions. Texture development was monitored during the conversion of production ingot stock to one quarter inch thick rolled plate as a function of thermomechanical processing. The three alloy compositions were 6Al-4V Ti ELIGrade, 6Al-4V Ti Standard Grade, and 6Al-2Sn-4Zr-6Mo Ti. Sufficient quantities of one specific textural type, basal transverse, were produced for all three compositions to permit extensive mechanical and fracture property testing at room and elevated temperature as a function of product orientation. Material properties evaluated were elastic modulus, monotonic stress—strain behavior, cyclic stress—strain behavior, notched and unnotched fatigue, and fracture toughness (Resistance Curves).

54796 (LBL—4920) **Influence of aluminum and aluminum plus silicon additions on the mechanical properties of AISI 4340 steel.** Bhat, M.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1977. Contract W-7405-ENG-48. 21p. (CONF-760398—1). Dep. NTIS, PC A02/MF A01.

From WESTEC 1976; Los Angeles, California, United States of America (USA) (8 Mar 1976).

The softening which occurs on tempering AISI 4340 steel is shown to be retarded by additions of aluminum or combinations of aluminum and silicon. The "500°F embrittlement" phenomenon in AISI 4340 steel occurs at higher tempering temperatures in the presence of aluminum and aluminum plus silicon in the steel. Significant improvements in the fracture toughness of low/medium alloy heat treatable steels are possible without a loss in strength through aluminum or aluminum plus silicon additions.

54797 (N—77—17431) **Problems associated with attaching strain gages to titanium alloy Ti—6Al—4V.** Jenkins, J.M.; Lemcoe, M.M. (National Aeronautics and Space Administration, Edwards AFB, Calif. (USA). Dryden Flight Research Center). Feb 1977. 19p. (NASA-TM-X—56044; H—970). NTIS, PC A02/MF A01.

Weldable strain gages have shown excellent high temperature characteristics for supersonic cruise aircraft application. The spotwelding attachment method, however, has resulted in serious reductions in the fatigue life of titanium alloy (Ti—6Al—4V) fatigue specimens. The reduction is so severe that the use of weldable strain gages on operational aircraft must be prohibited. The cause of the fatigue problem is thought to be a combination of the microstructure

changes in the material caused by spotwelding and the presence of the flange of the strain gage. Brazing, plating, and plasma spraying were investigated as substitutes for spotwelding. The attachment of a flangeless gage by plasma spraying provided the most improvement in the fatigue life of the titanium.

54798 (ORNL—5270, pp 87-126) **Alternate LMFBR structural materials.** Apr 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending December 31, 1976.

Development programs for alternate LMFBR structural materials are reviewed. Topics covered include: advanced ferritic alloys development, creep and stress rupture, aging results, welding development, elevated temperature properties; alloy 800 development, materials characterization, and the role of tertiary creep. 12 tables, 13 figs., 14 refs. (GHT)

54799 (SAND—75-8030) **Electroforming of a throat nozzle for a combustion facility (NASA Langley Reimbursable Program).** Dini, J.W.; Johnson, H.R. (Sandia Labs., Livermore, Calif. (USA)). Dec 1976. Contract E(29-1)-789. 39p. Dep. NTIS $4.00.

Special procedures were developed and then utilized for plating nickel over channels of a throat nozzle section of a NASA Langley combustor facility. When tested hydrostatically, the part failed in the stainless-steel substrate and not at the interface between the plating and substrate. The procedures used for plating the part are detailed as are high-temperature property data which show that the part can withstand long-term, high-temperature exposure without suffering degradation of the plated bond.

54800 (SAND—77-0308) **Short-time tensile properties of type 316 stainless steel from 0.6T/sub m/ to 0.9T/sub m/.** Marion, R.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). Apr 1977. Contract EY-76-C-04-0789. 16p. Dep. NTIS, PC A02/MF A01.

The mechanical properties of Type 316 stainless steel have been studied at temperatures from 760°C (1400°F) to 1204°C (2200°F) on the Short-Time High Temperature Mechanical Testing Facility. The results demonstrate that reasonable tensile behavior is retained at temperatures approaching the melting point if the strain rate is high enough.

54801 (SU—326P28X7) **Subgrain refinement strengthening. Fifth quarterly progress report, October 1, 1975—December 31, 1975.** (Stanford Univ., Calif. (USA). Dept. of Materials Science and Engineering). 1975. Contract EY-76-S-03-0326-038. 21p. Dep. NTIS, PC A02/MF A01.

Torsion and strain-rate-change compression testing of Nimonic PE-16 and types 316 and 321 stainless steel alloys was completed. The stress-strain curves in torsion at 500, 700, and 900°C for a constant strain rate ($6.0 \times 10^{-3}\ s^{-1}$ equivalent strain rate) were determined. The dislocation and subgrain structures which were developed at the different stress levels encountered during testing are under evaluation by TEM. Subgrain size measurements will be compared to measurements obtained from previous tests performed on similar materials by other investigators. Compression testing of the three alloys is currently under way. Initial data from the strain rate change compression tests are included. (DLC)

54802 Effect of residual elements on fracture characteristics and creep ductility of type 308 stainless steel weld metal. Stiegler, J.O.; King, R.T.; Goodwin, G.M. (Oak Ridge National Lab., TN). *J. Eng. Mater. Technol.;* 245-250(Jul 1975).

Previous studies had shown that conventional type 308 stainless steel weld metal can have low creep ductility (<1 percent total elongation) at 650 deg C. This paper demonstrates that the low ductility results from internal cracks that develop at austenite-sigma phase boundaries and propagate under the test conditions. The sigma phase is formed from ferrite present in the as-deposited weld metal. The 308 stainless steel weld metal containing controlled amounts of the residual elements B, P, and Ti also contains sigma phase, but phase boundary cracking has not been observed even after 5000 hr. The controlled residual element weld metal is significantly more ductile (<10 percent total elongation) than the conventional weld metals for which data are available.

54803 Mechanical properties of in situ composites. Lawley, A. (Drexel Univ., Philadelphia). pp 451-473 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

The general features of tensile, creep, fatigue, and impact loading of in situ composites are reviewed. Observed and predicted mechanical behavior is compared and property levels discussed and interpreted in terms of the underlying microstructure and mechanisms of strengthening. This approach provides both a basis and a perspective with which to assess the major advantages and limitations of in situ composites and to compare performance with that of synthetic composites and other advanced structural materials.

54804 Hot tensile properties and deformation reponse of a γ(Ni)/γ'(Ni$_3$Al)—δ(Ni$_3$Nb) eutectic composite. Bertorello, H.R.; Hertzberg, R.W.; Kraft, R.W. pp 517-527 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

Three distinct regions of tensile, deformation and fracture behavior were observed in a 2.5 wt% Al γ/γ'-delta eutectic alloy as the testing temperature was varied. The major finding was an extraordinary ductility maximum at about 550°C. It was shown that this phenomenon is caused by the deflection of transverse cracks at the eutectic grain boundaries when yielding occurs. This delamination between eutectic grains caused by fracture of a γ' eutectic grain boundary film leads to a distinctly different "wood-like" fracture surface morphology. Above 690°C to 926°C, yield and tensile strength values decrease while ductility increases slightly. Cooperative twinning of both phases develops giving rise to block-like deformation of the microstructure quite in parallel to the behavior observed previously in the γ-delta system.

54805 Micromechanical approach to the initiation of fiber fracture in some directionally solidified fibrous composites. Courtney, T.H. (Michigan Technological Engineering, Houghton). pp 529-537 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

A model is developed which estimates the additional stress components on the fiber, due to matrix slip, in directional composites. Since the points of initiation of fiber fracture during tensile testing of a number of directionally solidified composites have been found to coincide with matrix slip bands, this model appears relevant to fracture in these materials. As a first step in the prediction of fiber stresses resulting from matrix slip, the model predicts a stress state in the fiber which deviates considerable from stress states predicted by a rule-of-mixtures approach in Stage II of composite deformation. Application of the model to fiber fracture in a (Ni,Cr)-TaC directionally solidified eutectic predicts a more reasonable fracture stress for TaC than does the rule-of-mixtures approach.

54806 Assessment of toughness and cracking in the heat-affected zone of light water reactor components. Kussmaul, K.; Ewald, J. (Univ., Stuttgart). pp 627-646 of In Third international conference on pressure vessel technology. Part II. Materials and fabrication. New York; American Society of Mechanical Engineers (1976).

Basic investigations on the HAZ of component weldments involving testing of simulated samples have provided information on the possible decrease of toughness and/or the susceptibility to cracking due to the thermal-mechanical history of the component. The different steel types are classified according to the embrittlement and cracking behavior. Outstanding problems concerning the real lower bound toughness properties, and the significance with regard to the integral resistance of the component lead to a requirement for optimization of manufacturing processes and the introduction of new developments. In parallel with these aspects is the need to evaluate the real safety margin by applying additional testing concepts in the framework of a Water Reactor Safety Research Program on "Safety of Components."

54807 (BNWL-tr—226) **Investigations to improve the mechanical properties of electroslag welded joints of 60-mm-thick plates made of low-alloy steels.** Eichhorn, F.; Hirsch, P. Translated from Schweissen Schneiden; **28:** No. 3, 86-89(1976). 12p. Dep. NTIS $3.50.

It is examined whether the electrode melting rate and welding speed can be increased and the overheating of weld seam and heat-affected zone decreased by continuous supply of metal powder into the slag pool and high welding currents. 60-mm-thick plates of 15 NiCuMoNb 5, 13 MnNiMo 5, 4 and TTStE 36 are electroslag welded with two wire-electrodes. The mechanical properties of the joints (tensile test, hardness variation, notch toughness) are inspected in the as-welded condition and after heat treatment. The weld structure and the temperature distribution in the heat-affected zone are also described.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 54792, 54793, 54886

54808 (IS-M—91) **Generation of self-consistent Gibbs energy functions for binary systems: the Fe-Cu system as an example.** Smith, J.F.; Bailey, D.M.; Kubaschewski, O. (Ames Lab., Iowa (USA);

Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Metallurgie der Kernbrennstoffe und Theoretische Huettenkunde). 1977. Contract W-7405-ENG-82. 20p. (CONF-770116—3). Dep. NTIS, PC A02/MF A01.

From Workshop on application ot phase diagrams in metallurgy and ceramics; Gaithersburg, Maryland, United States of America (USA) (10 Jan 1977).

The basic problem concerning the prediction of multicomponent phase equilibria by extrapolation of binary Gibbs energy data is the development of good, self-consistent analytical descriptions of the temperature and composition dependences of the Gibbs energies of formation of the phases in the contributory binary systems. The general process for developing such Gibbs energy functions through combination of experimental thermodynamic data with experimental data concerning binary phase equilibria is illustrated by an analysis of a representative binary system, in this case the Fe-Cu system.

54809 Electron spin polarization in field emission from nickel: effects of surface adsorbates. Mueller, N. (Max-Planck-Institut fuer Plasmaphysik, Munich). *Phys. Lett., A;* **54:** No. 5, 415-416(6 Oct 1975).

Spin polarization of electrons field emitted from certain faces of more or less clean nickel is observed. The preferential spin direction is proved to depend on the crystal direction and on the adsorbate contamination of the face.

54810 Specimen for evaluating the area of SACPS. Verhoeven, J.D.; Baker, H.H. (Ames Lab., IA). *J. Mater. Sci.;* **11:** 388-389(1976).

The preparation of an Al—Ge sample that has proven to be effective in evaluating the minimum area of selected area channelling patterns is discussed. (GHT)

54811 Effect of a delta-phase stabilizer on the thermal diffusivity of plutonium. Lewis, H.D.; Kerrisk, J.F.; Johnson, K.W.R. (Los Alamos Scientific Lab., NM). pp 201-208 of Thermal conductivity. XIV. Klemens, P.G. (ed.). New York; Plenum Publishing Corp. (1976).

Thermal diffusivities of high purity plutonium and a delta-phase alloy containing 1.0 weight percent gallium were measured over the temperature range 20°C to 600°C. Measured diffusivity values of the high purity plutonium increased from about 0.011 cm^2/s at 20°C to 0.057 cm^2/s at 550°C, while the diffusivity for the delta-plutonium alloy increased from about 0.040 cm^2/s at 20°C to 0.065 cm^2/s at 400°C. Thermal conductivities were calculated from measured diffusivities for each type of sample using available specific heat and thermal expansion data. Thermal conductivities of the high purity plutonium samples showed a slight linear increase with temperature for each of the six allotropic crystalline forms. Values ranged from 3.2 W/m°C in the alpha temperature range to over 14 W/m°C in the delta temperature range, and are consistently lower than predicted for a free electron metal. Conductivities calculated for the delta-phase alloy ranged from 8.6 W/m deg at 25°C to 16.8 W/m deg at 400°C. The typical variation in L/L_0 over the temperature range was 0.66 to 0.89 for the high purity plutonium and 1.18 to 1.10 for the delta-phase alloy, where L_0 is the Lorenz number from the free electron model, and L is calculated from the experimental conductivities.

54812 Electron properties of amorphic and crystalline ytterbium films. Kuz'menko, V.M.; Mel'nikov, V.I.; Sudovtsov, A.I. (Khar'kov Physico-technical Institute, Ukrainian Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **44:** No. 4, 786-792(Oct 1976).

The electron properties (electric conductivity, magnetoresistance and Hall effect) of amorphous and crystalline ytterbium films are investigated at low temperatures. Some peculiarities are observed, especially a reduction of the resistivity of amorphous Yb films with decrease of their thickness. Information is obtained regarding the number of carriers, and their mobility and mean free path in the films. The differences in the properties of amorphous and crystalline Yb are ascribed to a shift of the conduction band relative to the valence band.

54813 Magnetostriction and thermal expansion of single crystals of the rare earth gadolinium-dysprosium alloys. Nikitin, S.A.; Kim, D.; Chistyakov, O.D. (Moscow State University; Metallurgy Institute, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **44:** No. 4, 843-848(Oct 1976).

The thermal expansion of single-crystal gadolinium-dysprosium alloys in a magnetic field is measured. The temperature dependence of the magnetostriction contributions to the thermal expansion is compared with that predicted by the theory in which isotropic two-ion exchange interactions and anisotropic one-ion magnetocrystal interactions are taken into account. It is found that the magnetostriction contribution to the thermal expansion along the c axis is mainly due to exchange interaction and, along the a axis, to both exchange and magnetocrystal interactions. It is shown that the derivatives of the exchange parameters with respect to interatomic distances are anisotropic and depend nonlinearly on the dysprosium concentration; an explanation of this may be the deformation of the Fermi surface in Gd/sub 1 - x/Dy/sub x/ alloys. The derivatives of the magnetocrystal energy with respect to interatomic distances depend linearly on the dysprosium concentration in accordance with the predictions of the one-ion theory.

54814 Helicons in indium single crystals in the intermediate state. Krylov, I.P. (Institute of Physics Problems, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **44:** No. 4, 848-855(Oct 1976).

Free and forced helicon oscillations in high-purity indium single crystals are investigated experimentally. The dependence of the helicon dispersion law and damping on the magnitude and direction of the magnetic field is studied. In agreement with the basic law of macroscopic electrodynamics, the dispersion law and damping of helicons are found to be independent of the structure of the intermediate-state domains. The resonance frequency of the oscillations in the plate do not depend on the concentration of the normal phase and decrease with inclination of the magnetic field relative to the normal to the plate surface. The damping of helicons in the intermediate state is independent of the inclination of the magnetic field. These facts are in agreement with Andreev's theory. (Zh. Eksp. Teor. Fiz. 51, 1510, 1966; Sov. Phys. JETP. 24 1019, 1967).

54815 NMR study of copper with vanadium impurities. Follstaedt, D.M.; Slichter, C.P. (Materials Research Laboratory, University of Illinois, Urbana, Illinois 61801). *Phys. Rev., B;* **16:** No. 1, 21-29(1 Jul 1977).

We present NMR data on copper with dilute vanadium impurities. We have measured the Knight shift of the ^{51}V impurity resonance and analyzed it in terms of a nonmagnetic virtual bound state. We have detected several host satellite resonances. One has a very large quadrupole coupling constant $\nu/sub\ Q/ \sim 3.5$ MHz and asymmetry parameter eta ~ 0.3; we identify it as the first-neighbor resonance. A magnetic satellite with shift $\Delta K/K = -0.658 +- 0.015$ is thought to be the resonance of the second or fourth neighbors. A satellite with weak magnetic coupling $\Delta K/K = + 0.2 +- 0.1$ is probably due to third neighbors. Our studies conclude that vanadium impurities in copper are magnetically similar to cobalt impurities.

54816 ^{93}Nb nuclear magnetic resonance and relaxation in Nb_3Sn, Nb_3Al, and Nb_3Sb. Fradin, F.Y.; Cinader, G. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **16:** No. 1, 73-81(1 Jul 1977).

The high-temperature superconductors Nb_3Sn and Nb_3Al and the low-temperature superconductor Nb_3Sb have been investigated by ^{93}Nb nuclear magnetic resonance and spin-lattice relaxation-time T_1 measurements. The relaxation-time results combined with electronic-heat-capacity results indicate that Nb_3Sn and Nb_3Al have similar densities of states at the Fermi level in the δ and π subbands, whereas Nb_3Sn has a much larger density of states at E/sub F/ in the σ subband. Nb_3Sb is a low density-of-states material. Large enhancements of $(T_1T)^{-1}$ (~300%) are found for T T/sub c/ in Nb_3Al and Nb_3Sn. The dependence of $(T_1T)^{-1}$ on (T-T/sub c/)/T/sub c/ suggests that highly anisotropic pair fluctuations exist well above T/sub c/.

54817 Polarized-neutron study of the magnetic moment distribution in PdMn alloys. Cable, J.W.; David, L. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **16:** No. 1, 297-301(1 Jul 1977).

Polarized-neutron diffuse-scattering methods were used to determine the spatial distribution of the magnetic moments in PdMn alloys containing 0.23-, 0.46-, 0.99-, and 1.91-at.% Mn. The measurements, made on polycrystalline samples at 4.2 K in an applied field of 45 kOe, show a moment of about $4\mu/sub\ B/$ localized at the Mn sites. The lower-concentration cross sections tend to increase at small reciprocal-lattice vector K, as expected for such "giant-moment" systems, while the two higher-concentration alloys show an anticorrelation corresponding to Mn spin reversal and/or positional short-range order. The cross sections are analyzed by assuming that the magnetic moment on a Pd atom depends on both its magnetic and chemical environment.

54818 Conduction-electron scattering in quenched and annealed gold. Chang, Y.K.; Crabtree, G.W.; Ketterson, J.B. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **16:** No. 2, 714-723(15 Jul 1977).

The anisotropy of conduction-electron scattering due to vacancies and stacking-fault tetrahedra (SFT) in quenching and subsequently annealing gold single crystals has been studied by measuring the de Haas-van Alphen (dHvA) Dingle(scattering) temperatures T/sub D/ for a large number of cyclotron orbits. The samples were quenched from 900°C into ice water, and were later annealed at 23 and 40°C. We find that the dHvA scattering rates 1/tau/sub dHvA/ due to both vacancies and SFT are much larger than those obtained from resistivity measurements 1/tau/sub rho/. The ratio of the [111] neck to belly orbital scattering rate rises from 1.0 for vacancies to 3.5 for SFT. This rise is attributed to the stronger and longer range

strain field associated with the larger defects. We have calculated the local lifetimes tau(k) from the measured T/sub D/ and found a large scattering anisotropy with strongest scattering arising from the [100] region.

54819 Optical examination of the electronic structure of single-crystal hcp scandium. Weaver, J.H.; Olson, C.G. (Synchrotron Radiation Center, University of Wisconsin-Madison, Stoughton, Wisconsin 53589). *Phys. Rev., B;* **16**: No. 2, 731-735(15 Jul 1977).

The optical absorptivity of a single oriented crystal of high-purity hcp scandium metal has been measured between 0.2 and 5 eV. The optical-conductivity spectra have been determined through Kramers-Kronig analysis. The results for scandium are compared with earlier results for single-crystal yttrium and the heavy lanthanide metals, particularly lutetium. Very strong similarities are shown to exist with nearly a one-to-one correspondence of structures for the various metals. The data are interpreted in terms of recent Sc band calculations by Das, and extensions of the calculations to other hcp metals, including considerations of dipole matrix elements, are urged.

54820 Fermi surface of technetium from a constant-energy-search Korringa-Kohn-Rostoker band-theory calculation. Faulkner, J.S. (Oak Ridge National Laboratory, Metals and Ceramics Division, Box X, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **16**: No. 2, 736-740(15 Jul 1977).

We generate two muffin-tin potentials for technetium using Slater exchange and calculate the Fermi energies and Fermi surfaces very accurately using the constant-energy-search Korringa-Kohn-Rostoker method. An explanation for experimental de Haas—van Alphen frequencies that were not previously understood is proposed. The bare-band theory contribution to the low-temperature specific heat is $\gamma_0 = 2.12$ mJ/mol K^2 for the better potential. We demonstrate the feasibility of using the methods outlined in this paper for carrying out highly detailed calculations on hcp metals.

54821 Theoretical estimate of the exchange-correlation enhancement of the spin susceptibility of scandium. MacDonald, A.H.; Liu, K.L.; Vosko, S.H. (Department of Physics and Erindale College, University of Toronto, Toronto, Ontario, M5S 1A7). *Phys. Rev., B;* **16**: No. 2, 777-784(15 Jul 1977).

A variational principle—spin density functional theory has been used to calculate the zero-temperature spin susceptibility of scandium. The exchange-correlation functionals which appear are treated in the local-spin-density approximation. The single-particle electron states are calculated by the augmented-plane-wave method using a self-consistent muffin-tin potential. It is argued that the reasonable agreement between the anomalous measured magnetic form factors and those calculated in a single-particle picture shows the appropriateness of the trial magnetization density used in the variational principle. The theoretical spin susceptibility was found to be 281 x 10^{-6} emu/mole corresponding to an exchange-correlation enhancement factor of 4.03 over the single-particle (band) value. This result is in good agreement with the measured total susceptibility and recent theoretical estimates of its other components.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 53931, 53946, 54029, 54083, 54341

54822 (CONF-770303—12) **Effect of a high heat flux on the corrosion of 2 1/4 Cr-1 Mo steel in superheated steam.** Griess, J.C.; DeVan, J.H.; Maxwell, W.A. (Oak Ridge National Lab., Tenn. (USA); NUS Corp., Clearwater, Fla. (USA)). 1977. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

From Corrosion/77 NACE meeting; San Francisco, California, United States of America (USA) (14 Mar 1977).

A series of corrosion tests was conducted to determine the effect of heat flux on the corrosion of 2¼ Cr-1 Mo steel in superheated steam. The tests were conducted with a constant heat flux of (126 kW/m^2) 40,000 Btu hr^{-1} ft^{-2} and surface temperatures varying from 950 to 1000°F (510 to 541°C) on each specimen. Specimens were exposed for varying lengths of time, ranging from 500 to 6000 hr. Essentially all the corrosion product oxide remained on the steel during the first 2000 hr, but after that time, exfoliation of the oxide began. The percentage of corrosion product oxide lost from the specimen increased with exposure time; about 33 percent was missing after 6000 hr. After an initial period of rapid corrosion, the average corrosion rate was constant at 1.8 mils/year (45 μm/year). In contrast, isothermal specimens exposed to superheated steam at 930°F (499°C) in the same test facility corroded at a decreasing rate throughout the test. Metallographic sections showed that, with heat transfer across the specimen-steam interface, both cracks and porosity developed in the oxide, even on short exposure, a face that was undoubtedly responsible for the early exfoliation of the oxide and the constant corrosion rate.

54823 (ORNL/TM—5863) **Corrosivity of geothermal brines. Progress report ending December 1976.** Posey, F.A.; Palko, A.A.; Bacarella, A.L. (Oak Ridge National Lab., Tenn. (USA)). Apr 1977. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A03/MF A01.

Studies carried out on the corrosion of ferrous materials in synthetic geothermal brines are described. Several modifications were made to the original designs of the reference and test electrode assemblies of the refreshed, stirred titanium autoclave system for making electrochemical measurements up to at least 200°C. These changes greatly improved the reliability of the experimental system. Anodic and cathodic polarization curves were measured for type A212B carbon steel in 4 M NaCl at pH = 5 up to 200°C. On the basis of extrapolation of Tafel lines from these measurements and on the basis of measurements of polarization resistance it was possible to estimate the spontaneous corrosion rate of A212B carbon steel in deaerated 4 M NaCl, pH = 5, from room temperature up to 200°C. The influence of sweep rate and direction on estimation of corrosion rates from potentiodynamic polarization curves is discussed. The influence of chloride ion concentration on the anodic polarization behavior and the spontaneous corrosion rate of iron at 25°C, pH = 5, is described. Plans for continuation of the research during the remainder of FY1977 are presented.

54824 (SAND—76-8517) **Corrosion resistant coatings for uranium and uranium alloys.** Weirick, L.J.; Lynch, C.T. (Sandia Labs., Livermore, Calif. (USA)). Jan 1977. Contract E(29-1)-789. 50p. (CONF-770303—2). Dep. NTIS $4.00.

From Corrosion/77 NACE meeting; San Francisco, California, United States of America (USA) (14 Mar 1977).

Coatings to prevent the corrosion of uranium and uranium alloys are considered in two military applications: kinetic energy penetrators and aircraft counterweights. This study, which evaluated organic films and metallic coatings, demonstrated that the two most promising coatings are based on an electrodeposited nickel system and a galvanized zinc system.

54825 High temperature oxidation behavior of directionally solidified Ni_3Al—Ni_3Ta, Ni—Ni_3Al—Ni_3Ta, and (Co,Ni)—(Co,Ni) Al eutectics. Mollard, F.R.; Lux, B. (Geneva Research Center). pp 385-396 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

The high temperature oxidation resistance in air of several nickel and cobalt base directionally grown eutectics has been evaluated by means of isothermal and cyclic tests. The isothermal tests were carried out at 1100°C for times up to 200 hours. In the cyclic tests the samples were held for 5 hours at 1100°C, rapidly cooled down to room temperature and reheated, also for a total duration of about 200 hours. The weight gain of the ternary Ni-Ni_3Al-Ni_3Ta eutectic was found to be about six times that of the binary Ni_3Al-Ni_3Ta eutectic after 200 hours of isothermal exposure at 100°C. Additions of 6% chromium to the ternary eutectic decreased its weight gain after 200 hours at 1100°C by a factor of about 25 under isothermal conditions and by a factor of about 60 in cyclic tests. In the Co-Ni-Al system, all the alloys investigated (Co-8Ni-10Al, Co-24Ni-11Al and Co-33Ni-12Al) were found to have better oxidation resistance than either the binary or ternary Ni-Al-Ta eutectics. For a comparable Al content, their oxidation performance improved with increasing Ni content. The Co-33Ni-12Al alloy had the best oxidation characteristics of the series, with an isothermal weight gain of 1 mg/cm^2 after 100 hours at 1100°C. This is comparable to the oxidation resistance of Ni-Ni_3Al-Ni_3Ta + 6% Cr, that is equivalent to that of the IN 713 C nickel-base superalloy and considerably better than the MAR M-509 cobalt-base superalloy.

54826 Oxidation behavior of some aligned eutectic and eutectoid alloys. Smeggil, J.G. pp 397-405 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

The continuing desire for alloys exhibiting improved mechanical properties at elevated temperatures as compared with those obtainable from conventional superalloys has led to considerable effort in the areas of aligned in situ composites. An examination of the isothermal oxidation behavior of some simple aligned composites indicated that effects varied as a function of both the oxidation temperature and the chemistry and microstructure of the specific composite. At low temperatures, the fibrous TaC-Co eutectics, dependent upon Cr level, exhibit both selective oxidation of the Co-matrix along preferred crystallographic planes and inversions in oxidation rates with increasing temperature. At Cr levels of 5 wt. % or less, the four component Ni(Cr)-TaC eutectic alloys exhibit rapid dissolution of the TaC fiber at temperatures of 1000°C or higher. Increasing Cr and Al either raises the temperature for dissolution or keeps the TaC fibers intact up to the highest temperature examined

here, 1200°C. Lamellar microstructures exhibit decidedly different mechanisms for oxidation at sufficiently high and low temperatures. In the case of the Ni_3Al-Ni_3Nb (or γ'-delta) and the Ni(Cr)-Ni_3Al-Ni_3Nb (or γ-γ' - delta) eutectics and the Co-Co_2Si eutectoid, the oxidation prone phase, Ni_3Nb or Co, is preferentially attacked at low temperatures. On the other hand at sufficiently high temperatures, the γ'-delta and γ'-γ'-delta eutectics develop an Al-rich protective oxide layer. This results in the significant (if not total) conversion of Ni_3Al to γ - Ni. At high temperatures, the Co-Co_2Si eutectoid forms a Si-enriched oxide layer above a layer of Co_2Si which in turn surrounds the coarsened eutectoid structure.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 54344, 54352, 54501, 54938, 55482, 55507, 55512, 55515, 55519, 55523

54827 (AD-A—038686) **Characterization of the dynamic behavior of porous solids. Volume 4. Electron beam studies of porous beryllium and porous ceramics. Final report 14 Jan 74—31 Jan 76.** Lutze, A.B.; Ginsberg, M.J.; Curran, D.R. (Stanford Research Inst., Menlo Park, Calif. (USA)). Mar 1976. Contract DNA001-74-C-0150. 58p. NTIS PCA04/MF A01.

See also Volume 7, AD-A—038685.

This work was part of a two-year program to characterize the response of porous, refractory materials to rapid energy deposition. The objective of the electron-beam experiments reported here was to obtain stress—time profiles for porous ceramics and beryllium in the high internal-energy region of the equation-of-state surface. Stress—time profiles or, alternatively, particle velocity histories were recorded with piezoresistive gages and interferometric techniques, respectively. Test materials selected for characterization were (1) sintered and flame-sprayed alumina (Al_2O_3), (2) plasma-sprayed aluminum titanate (Al_2TiO_5), and (3) plasma-sprayed distended beryllium (PSDB).

54828 **Annealing behaviour of Al doped with 0.3 at % Ge after low temperature irradiation.** Haubold, H.G. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Festkoerperforschung); Larson, B.C. (Oak Ridge National Lab., Tenn. (USA). Solid State Div.). *Verh. Dtsch. Phys. Ges.;* No. 1, 305(1977). (In German).

From Spring meeting of the Arbeitskreis Festkoerperphysik at the Deutsche Physikalische Gesellschaft e.V. in conjunction with the Nederlandse Natuurkundige Vereninging and 2. symposium on solid state device technology; Muenster, Germany, F.R. (7 - 12 Mar 1977).

Short communication only.

54829 (CONF-750839—3) **Gas release from surfaces under x-ray impact: photodesorption, photocatalysis.** Brumbach, S.; Kaminsky, M. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-ENG-38. 31p. Dep. NTIS $4.00.

From Symposium on radiation effects on solid surfaces; Chicago, Illinois, USA (25 Aug 1975).

Energetic photons impinging on surfaces of solids can cause gas release by photodesorption, photodecomposition, and photocatalysis. Experimental data on x-ray induced gas adsorption and gas release from surfaces will be reviewed. Results from experiments using photons of lower (e.g. visible or uv-range, synchrotron radiation) or higher energy (γ-rays) will only be included in the review to the extent they are needed to interpret the data obtained with photons in the x-ray range. The importance of x-ray induced photodesorption in the attainment of ultrahigh vacuum in electron storage rings and in plasma containment experiments will be discussed.

54830 **Radiation-induced damage in molybdenum single crystals subjected to ionic irradiation.** Bykov, V.N.; Zdorovtseva, G.G.; Troyan, V.A.; Khmelevskaya, V.S.; Malynkin, V.G. *Sov. Phys. - Crystallogr. (Engl. Transl.);* 22: No. 1, 76-79(Jan 1977).

Changes taking place in the lattice constant and microhardness of molybdenum single crystals irradiated with 50 keV helium ions along the (111), (100), and (110) directions were studied. The lattice constant was reduced in every case. These changes intensified on moving away from the surface into the interior of the radiation-damaged layer, reaching a maximum value at a depth of ~1 μ, the total depth of the radiation-damaged layer being tens of microns. On annealing at 180degreeC the reduction in lattice constant intensified for all three directions. Microhardness measurements showed that after irradiation the hardness of the samples increased by some 30—40%; the effect of diminished with depth, but still remained perceptible at a depth of several microns. Helium was only recorded mass-spectrometrically close to the sample surface. After etching away a layer 1.5 μ thick the rate at which helium left the sample had fallen to a value commensurable with the background count of the instrument.

54831 **Comparative study of uniaxial channeling-blocking and single-alignment channeling backscattering: reversibility and defect analysis.** Pronko, P.P.; Thompson, L.J. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* 16: No. 1, 4-9(1 Jul 1977).

Scattering yields are examined for 200-keV-proton channeling in silicon and gold under conditions of single and double alignment. Results are presented for 180° uniaxial channeling—blocking and 150° channeling—backscattering for nondamaged but thermally vibrating crystals (300 K). The analysis of the data is approached, however, from the point of view of the formalism required for decomposing an arbitrary mixture of interstitial and lattice-distortion-type crystal defects in order to assess the applicability of the reversibility rule of channeling and blocking to the defect analysis equations. In the limiting condition of thermal dechanneling it is observed that the equations are applicable only when the double-aligned spectra are corrected for the energy dependence of scattering into blocking configurations. The transformation is discussed in terms of scaling according to a set of energy-loss parameters that can be obtained from the scattered-energy spectrum. These procedures appear necessary since strict reversibility in channeling and blocking cannot be expected under conditions where electronic stopping introduces significant energy loss during penetration of the channeled beam.

CERAMICS, CERMETS, AND REFRACTORIES

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 54014, 54859

54832 (ANL—7235) **Tungsten cladding of W-UO_2 nuclear-rocket fuel subsections by vapor deposition.** Battles, J.E.; Edwards, R.K.; Gunderson, G.E.; Shinn, W.A. (Argonne National Lab., Ill. (USA)). Dec 1967. Contract W-31-109-ENG-38. 34p. Dep. NTIS $4.00.

A program was conducted to develop a process for cladding tungsten-uranium dioxide hexagonal, 331-hole reference fuel subsections with tungsten deposited from the vapor state by the hydrogen reduction of tungsten hexafluoride. Hydrogen reduction of WF_6 was selected primarily because WF_6 is gaseous at room temperature, requires lower temperatures for deposition, and would yield the purest deposits.

54833 (ORNL—5270, pp 203-211) **Advanced absorber materials.** Tennery, V.J. Apr 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending December 31, 1976.

Efforts to characterize and establish the physical and engineering properties and behavior of advanced neutron absorber materials are reported. Eu_2O_3-W cermet development is discussed. 4 figs, 2 tables. (GHT)

54834 **Preparation and characterization of Cr—Cr_2O_3, Al_2O_3—ZrO_2 (Y_2O_3) eutectics.** Hulse, C.O. (United Technologies Research Center, East Hartford, CT). pp 99-106 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

A progress report is presented on current research efforts to develop metal whisker reinforced ceramic-matrix eutectics suitable for use uncoated to temperatures of 1315°C and higher in gas turbine engines. Directionally solidified ingots have been successfully prepared using 3/8 in. internal diameter CVD tungsten tubes as containers in an argon atmosphere. The presence of the metal phase in the ceramic should improve the resistance of the ceramic to damage by thermal shock and may also add some ductility, especially at elevated temperatures, which may increase the toughness and reduce the scatter in strength data. The compositions of potentially oxidation resistant binary eutectics between Cr and solid solutions of Al_2O_3 and Cr_2O_3 are reported. A directionally solidified ingot of 19 w/o Cr - 55.2 w/o Cr_2O_3, 25 w/o Al_2O_3 showed only a few mils of attack after 60 hrs in static air at 1425°C. A ternary eutectic composition at 24 w/o Cr - 23.5 w/o Cr_2O_3, 23.5 w/o Al_2O_3 - 25 w/o ZrO_2, 4 w/o Y_2O_3 contained whiskers of stabilized ZrO_2 in addition to those of the metal phase. This eutectic could be grown plane front at speeds below approximately 0.8 cm/hr but the whiskers of both minor phases were short and irregular. A very regular morphology with long, straight whiskers was obtained by growth parallel to the [0224] from a sapphire seed. This eutectic unseeded exhibited a weight gain of only approximately 3% after 52 hrs in static air at 1425°C. The average strength of this eutectic at 1540°C was 23,400 psi.

54835 **Directional solidification by internal zone melting of Cr_2O_3—Mo composites.** Holder, J.D.; Clark, G.W. (Oak Ridge Na-

tional Lab., TN). pp 107-113 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

Thermodynamic calculations were used to select an optimum P/sub O_2/ for the melting of Cr_2O_3-Mo eutectic composites using CO/CO_2 gas mixtures. Directionally solidified composites of Cr_2O_3-28, -35, and -40 mole % Mo have been grown by the internal zone growth (IZG) technique at growth rates of 0.5 to 5 cm/hr. A dendrite-free, rod eutectic-like structure was formed in all samples of controlled directional growth. The spacing of Mo rods was measured and found to closely satisfy the lambda^{2}R = constant criteria for steady state growth.

54836 Solidification of Cr_2O_3—W eutectic composites. Briggs, J.; Mollard, F.R.; Lux, B. (Geneva Research Center). pp 115-125 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

A directional solidification technique using zone melting in a tungsten crucible has been found suitable for the preparation of oxide-metal in situ composites based on the Cr_2O_3-W eutectic. This eutectic has a melting point of 1850°C. Its microstructure consists of approximately 12 volume percent of continuous fibres of pure W in a Cr_2O_3 matrix. With an initial composition of 4 volume percent W, a zone temperature of 1950°C and a growth rate of 6 cm/h, it was possible to obtain sound samples with a tungsten fibre diameter of 1 μ. It was however difficult to produce samples completely free of tungsten dendrites. The preliminary property evaluation was therefore conducted on off-eutectic Cr_2O_3-W composites, for which a room temperature work of fracture equal to about 15 times that of sintered Cr_2O_3 was measured. Izod impact tests showed that the composites absorbed 6 times as much energy as sintered Cr_2O_3, and 1.5 times as much as recrystallized Al_2O_3. Creep tests in bending at temperatures up to 1550°C showed a deformation for the composite which was 5 times less than that of sintered Cr_2O_3. Oxidation in air at temperatures up to 1100°C led to the disintegration of the off-eutectic samples because of the presence of primary dendrites, associated cracks and grain boundaries. However, the fine tungsten fibres in the eutectic grains did not appear to have been oxidized. Preparation of pure and structurally sound eutectic samples as well as the development of other systems is considered essential to realize the full potential of this new class of materials.

54837 Annealing of directionally solidified Cotac-alloys in a transverse thermal gradient. Blank, E. pp 167-178 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

Cotac eutectics directionally solidified at 0.6 cmph and 1.7 cmph were annealed in a temperature gradient (100°C/mm) transverse to the fibre axis. Three reactions were observed which lead to complete dissociation of the fibres. One of the reactions is initiated by thermal migration, the two other reactions occur by recrystallization involving grain-boundary migration. Driving forces are discussed. General importance of the results for directionally solidified high temperature eutectics is outlined.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 54837, 54859

54838 Thermal stability and creep properties of niobium—niobium carbide (Nb_2C) composites grown from the melt. David, S.A.; Lin, K.Y.; Brody, H.D. (Univ. of Pittsburgh). pp 561-572 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

Niobium-niobium carbide (Nb_2C) composites have been employed to study the effect of microstructure on the thermal stability of high temperature in situ composites. The structural stability of as grown Nb-Nb_2C composites with rod-like carbide morphology grown at two different growth rates, and the stability of deformed Nb-Nb_2C composites have been examined after isothermal annealing at temperatures in excess of one half the eutectic temperature for periods up to 700 hours. During annealing of the undeformed composites the carbide phase undergoes two dimensional coarsening. The rod density is decreased but a high aspect ratio is maintained. After a long anneal the rods combine to form plates. Deformation and high temperature exposure of the composites lead to the breakdown of the fibers along their length and spheroidization of the fibers into globules. Coarsening kinetics were also followed for samples containing lamellar carbide morphology with two different spacings. The major change on exposure to elevated temperatures in these samples was a slight increase in lamellar spacing with a thickening of the carbide platelet at 1500°C anneal and no change at 1100°C anneal. Preliminary creep tests of Nb-Nb_2C in situ composites indicated that the creep behavior of samples containing rod-like and lamellar carbide morphologies was comparable. Steady state creep rates at 1300°C and 86.9 mpa were of the order of .0002 hr^{-1} Creep rates and rupture times are dependent on defects in the microstructure.

54839 Interaction of Sc_2O_3 and TiO_2 at high temperatures. Lyashenko, L.P.; Shcherbakova, L.G.; Glushkova, V.B.; Tatarintsev, V.M. (Institute of Chemical Physics, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Dokl. (Engl. Transl.);* **22**: No. 1, 3-4(Jan 1977).

X-ray spectra were obtained for solid solution of Sc_2O_3 and TiO_2 in the temperature range 1100—1750degreeC. The solubility of each material in the other was determined, and diagrams of the crystal-phase transformations were produced.(AIP)

54840 Chemically bound hydrogen in CVD Si_3N_4: dependence on NH_3/SiH_4 ratio and on annealing. Stein, H.J. (Sandia Labs., Albuquerque, NM); Wegener, H.A.R. *J. Electrochem. Soc.;* **124**: No. 6, 908-912(Jun 1977).

The effects of the ammonia-to-silane ratio, R, during deposition and of postdeposition heating on chemically bound H in 1000A silicon nitride films were investigated by using miltiple internal reflection (MIR) spectroscopy. The films were deposited at 700°C with R equal to 10:1, 100:1, and 1000:1 in an Ar carrier gas. Vibrational modes for N-H and Si-H bonded centers show that H is incorporated into the films. The sum of the NH and SiH band intensities (total bound H) increased with R. The SiH band intensity, however, was largest in the 100:1 film. The increase in bound H with R is attributed to an increase in reactive H from NH_3 decomposition in the presence of incompletely bonded Si and N. The decrease in SiH centers when R is increased from 100:1 to 1000:1 is attributed to more complete Si-N bonding. Annealing behavior at 800°C suggests an initial transfer of H from N-H to Si-H bonds in 10:1 and 100:1 films consistent with the presence of incompletely bonded Si. Bonding of implanted H in Si_3N_4 was demonstrated by isotopic substitution of D for H, and a calibration to determine H concentrations from MIR measurements was obtained. Bond energy-limited H loss is suggested to explain an observed mass-independent annealing for implantation-preduced NH and ND centers. 9 figures.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 54836, 54859

54841 (Y/DA—6925) Low-density carbon fiber composites. Reynolds, C.D.; Ardary, Z.L. (Oak Ridge Y-12 Plant, Tenn. (USA)). Oct 1976. Contract W-7405-ENG-26. 44p. Dep. NTIS, PC A03/MF A01.

Low-density discontinuous carbon fiber composites have attractive properties for utilization in the aerospace, nuclear reactor, and high-temperature furnace applications as a shock-resistant structural thermal-insulating material. They are quite refractory, have a high ratio of strength to weight, a low coefficient of thermal conductivity, high resilience, and excellent toughness. Mechanical and thermal property data are present for the basic, low-density carbon fiber composite system (typically 0.1 to 0.3 g/cc density). High-strength varieties, with densities between 0.3 and 0.9 g/cc and compressive strengths ranging to nearly 90 MPa, were prepared and evaluated for thermal and physical characteristics. Methods of improving composite resilience were investigated, leading to the development of materials which fully recover on unloading from 20 percent strain, and with a permanent set of less than 5 percent on unloading from 50 percent strain.

54842 Structure and properties of ZrO_2—Ta eutectics. Roeser, K.; Claussen, N. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 127-135 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975).

See CONF-7509185—.

Aligned eutectic structures in the system ZrO_2-Ta have been prepared by internal zone melting. Crack-free specimens were obtained even though stabilizing oxides were not added. A maximum fracture toughness of 9.7 MN/m/sup $^3/_2$/was measured when the crack was perpendicular to the Ta fibers. The highest work of fracture value for the same condition was 370 J/m^2. Due to the high oxygen conductivity of ZrO_2, the oxidation resistance of ZrO_2-Ta composites is very low. Air annealing at 830 K for 2 h causes complete disintegration of the specimens.

54843 High cycle fatigue of a CoCrNi—TaC aligned eutectic. Koburger, C.; Stoloff, N.S.; Duquette, D.J. (Rensselaer Polytechnic Inst., Troy, NY). pp 587-596 of In Conference on in situ composites. II. Jackson, M.R. (ed.). Lexington, MA; Xerox Individualized Publishing (1976).

From 2. conference on In Situ composites (CISC-II); Lake George, New York, United States of America (USA) (2 Sep 1975). See CONF-7509185—.

High cycle tension-tension fatigue tests at room temperature and at 1000°C were conducted on a Co-10%Ni-10%Cr-14Ta-1%C directionally solidified eutectic. The room temperature S-N plot exhibited two distinct curves which converged at lower stress levels. The upper curve results when no cracking of the TaC reinforcing fibers occurs except at the crack tip. The lower curve is observed either when widespread fiber cracking occurs on the first cycle (the maximum stress being above that required to fracture fibers), or when fibers are precracked by overload followed by fatigue testing conducted below the minimum stress required to break fibers. The fatigue crack path of all room temperature specimens was macroscopically oriented at 90° to the tensile axis but microscopically consisted of Stage I (crystallographic) facets. Fibers intersecting the fracture surface showed classical cleavage characteristics indicating brittle fracture. At 1000°C fatigue strengths were reduced by a factor of three and precracking of fibers led to a still lower fatigue resistance. The characteristics of fatigue crack initiation and propagation are discussed in relation to the characteristic deformation of these alloys at each temperature.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 54833, 54841, 54859

54844 (AD-B—009131) **Radiation and thermally hardened switching materials. Final report 1 Jul 72—30 Jun 75.** Shin, S.H.; Raccah, P.M. (Yeshiva Univ., New York (USA). Belfer Graduate School of Science). Jan 1976. Contract DAAB07-72-C-0297. 83p. NTIS PCA04/MF A01.

The field switching properties of NbO_2/NbO, NbO_2/(reduced NbO_2) and polycrystalline nonstoichiometric NbO_2 have been investigated. Under an applied electric field they switch from a high (greater than 10,000 ohms) to a low (approximately 10 ohms) resistance in times smaller than 0.7 ns. For pulse durations of several nsec, the current carrying capability is higher than 80 A. The switching mechanism appears to proceed in two stages which could be electrode limited Schottky barrier breakdown and bulk limited field lowering process of NbO_2, then followed by a thermal runaway.

54845 (COO—2390-16) **Basic research in crystalline and noncrystalline ceramic systems. Annual report, May 1, 1976—April 31, 1977.** (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Materials Science and Engineering). 1977. Contract EY-76-S-02-2390. 92p. Dep. NTIS, PC A05/MF A01.

Research efforts from May 1, 1976 to April 31, 1977 are summarized. Twenty-one individual projects are described in four sections. The sections are: electrical, optical and dielectric properties of uranium dioxide, aluminum oxide, and magnesium oxide; microstructure development during processing and evolution in service under various driving forces, and effects on properties; kinetic studies including factors affecting ion transport and diffusion; and defect interactions, solute distribution, grain boundary phenomena and influence on properties. (GHT)

54846 Magnetic structure of TbD_2: A neutron diffraction study. Shaked, H.; Faber, J. Jr.; Mueller, M.H.; Westlake, D.G. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **16**: No. 1, 340-346(1 Jul 1977).

Terbium dideuteride has been examined by elastic neutron scattering. Crystallographic parameters have been determined at 300 and 77 K. It was found that TbD_2 undergoes a para- to antiferromagnetic transition at T/sub N/ = 17.2(3) K. The magnetic structure at 4.6 K was determined and found to belong to the monoclinic space group C_2/sub c/2/m'. The magnetic moment per Tb^{3+} ion is 7.6(3) μ/sub B/ at 4.6 K. The reduction from the free-ion value of 9.0 μ/sub B//Tb^{3+} is due to crystalline electric field effects that are also apparent in the temperature dependence of the sublattice magnetization.

54847 Mollwo-Ivey relation between peak color-center absorption energy and average oxygen ion spacing in several oxides of group-II and -III metals. Bunch, J.M. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). *Phys. Rev., B;* **16**: No. 2, 724-725(15 Jul 1977).

A simple relationship similar to that reported by Mollwo and Ivey relating peak absorption energy to the lattice parameter in the alkali halides has been noted for several oxides of group II and III metals, including BeO, Al_2O_3, $MgAl_2O_4$, $Y_3Al_5O_{12}$, and most of the cubic alkaline-earth oxides. Instead of the lattice parameter, the average oxygen spacing, which may be defined independent of crystal structure, is taken here as the independent variable.

CORROSION AND EROSION

54848 (AD-B—004711) **Radiation and thermally hardened switching materials. Semi-annual report No. 5, 1 Jul—31 Dec 74.** Raccah, P.M. (Yeshiva Univ., New York (USA). Belfer Graduate School of Science). Apr 1975. Contract DAAB07-72-C-0297. 11p. NTIS PCA02/MF A01.

Over the past six months work was concentrated on the analysis of longevity factors of niobium dioxide devices. Some of the difficulties recognized were oxidation of the NbO_2 layer around the electrode contact and short, sputtering away of the W whisker's tip and wandering which makes for non-reproducibility of device characteristics. Potting of the assembly and use of an intermediate In dot seem to alleviate the problems. Further testing is in progress at Fort Monmouth. In addition, two new device structures were developed for the regular devices using cheaper Nb metal sheets instead of NbO single crystal chips, and for long, intense pulses using directly single crystal NbO_2.

54849 (LA—6780-MS) **Study of materials compatibility with HF, F_2 and F_2 for combustion laser application.** Wallace, T.C.; Feber, R.C.; Hauth, W.E. (Los Alamos Scientific Lab., N.Mex. (USA)). May 1977. Contract W-7405-ENG-36. 72p. Dep. NTIS, PC A04/MF A01.

A thermodynamic-kinetic basis is proposed for selecting refractory materials for use in the corrosive environment of a combustor-driven HF(cw) laser. The most corrosion-resistant materials appear to be sesquioxides which form a protective layer of oxyfluoride at the oxide—gas interface. Thermodynamic and transport properties of numerous gaseous fluoride molecules are tabulated. Requirements for a component materials development program are also discussed. 5 figures, 54 tables

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 54568, 54827

54850 (AD-A—038639) **A study of silicon oxide growth mechanisms for the purpose of identifying hardness assurance total dose screens. Final report.** Maier, R.J. (Air Force Weapons Lab., Kirtland AFB, N.Mex. (USA)). Feb 1977. 40p. (AFWL-TR—76-228). NTIS PCA03/MF A01.

Processes exist today which will produce oxide layers on silicon semiconductor devices with total ionizing surface effects sufficiently suppressed to satisfy military needs. An acceptance test, called a hardness assurance screen, is needed. To identify possibilities for these tests, the literature was searched, analyses were performed, and special wooden ball molecular models were studied. The current model of oxide layer growth and the relations of such growth to total dose susceptibility were gleaned from the literature. This model was extended by the study as follows: Qss is caused by an oxygen atom which is bonded to three interface silicon atoms. This produces an interface donor state whose energy is above the silicon conduction band. Nss is primarily caused by a Si-0-Si bond in which the oxygen has been removed leaving a stretched Si-Si bond. This produces two interface states; a donor level near the valence band and an acceptor level near the conduction band.

54851 (COO—5000-2) **Preparation, characterization, and use of metal hydrides for fuel systems. Progress report, September 1, 1976—May 31, 1977.** Herley, P.J. (State Univ. of New York, Stony Brook (USA). Dept. of Materials Science). May 1977. Contract EY-76-S-02-2715. 80p. Dep. NTIS, PC A05/MF A01.

The isothermal decomposition kinetics of unirradiated and irradiated powdered lithium aluminum hydride have been determined in the temperature range 125 to 155°C. The resulting activation energies for unirradiated material for the induction, acceleratory, decay and slow final rate were, respectively, 116.8, 94.3, 87.1 and 12.9 +- 4.6 KJ/mole. For preirradiated powders (1.25×10^5 rad) activation energies for the same periods were 119.0, 99.5, 80.5 and 10.0 +- 4.6 KJ/mole, respectively. Admixture with powdered aluminum, nickel and final reaction product did not affect the subsequent thermal decomposition. Exposure to dry air and carbon dioxide do not affect the decomposition, but 2 minute exposure to saturated water vapor reduces the percentage decomposition by almost 50%. An extensive differential scanning calorimeter study has been made of $LiAlH_4$ (irradiation and water vapor effects), AlH_3 and $NaAlH_3$ (irradiation effects). The results indicate that irradiation tends to move the existing peaks to lower temperatures and at higher doses may even introduce additional peaks. The data above were analyzed using a cubic acceleratory period equation and a monomolecular decay law. In addition the analysis shows that irradiation increased the concentration of decomposition nuclei and the rate that potential decomposition sites are converted to active sites. These observations suggest that the same process is occurring in

both irradiated and unirradiated lithium aluminum hydride, but that the rate constants are increased by prior irradiation. The photolytic decomposition of powdered $LiAlH_4$ and AlH_3 is markedly reproducible with no dark rate occurring in both instances. Magnesium hydride is also readily photolyzed with the BH_6 lamp and the actinic wavelength and intensity-rate relationships are being determined.

COMPOSITE MATERIALS

54852 (NTIS/PS—77/0363) **Boron reinforced composites. Volume 1. 1972—1975 (a bibliography with abstracts). Report for 1972—75.** Lehmann, E.J.; Cavgnaro, D.M. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 224p. NTIS PCN01/MF N01.

The cited reports cover the uses of boron, especially boron fibers and boron compounds, as a reinforcing material in composites. The topics include fabrication, testing, uses, and structural and mechanical properties. (This updated bibliography contains 219 abstracts, none of which are new entries to the previous edition.)

54853 (NTIS/PS—77/0364) **Boron reinforced composites. Volume 2. 1976—May, 1977 (a bibliography with abstracts). Report for 1976—May 77.** Cavagnaro, D.M. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 148p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0420, NTIS/PS—75/414, and COM—74-10854.

The bibliography cites Federally-funded research on boron fibers and boron compounds used as reinforcing material in composites. Included are studies on fabrication, testing, uses, and structural and mechanical properties. (This updated bibliography contains 143 abstracts, all of which are new entries to the previous edition.) See also NTIS/PS-77/0363, Boron Reinforced Composites. Vol. 1. 1972-1975.

PREPARATION AND FABRICATION

54854 (BNL—50626) **Development of a glass polymer composite sewer pipe from waste glass. Progress report No. 2, October—December 1976.** Steinberg, M.; Kukacka, L.E. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 15p. Dep. NTIS, PC A02/MF A01.

Large quantities of energy and money can be conserved by recycling solid urban waste. While uses for recycled ferrous and non-ferrous metals are apparent, uses for the glass fraction have not been identified. As a result, a program to develop methods for incorporating waste glass into composites which can be used for construction materials was started in July 1976. Since that time tests have been started to measure the properties of glass-polymer sewer pipe. Field testing of full-scale specimens is also in progress. Work accomplished during the period October 1-December 31, 1976 is described in the current report.

MECHANICAL PROPERTIES

54855 (AD-A—038080) **Thermoelastic properties of unidirectional filamentary composites by a semiempirical micromechanics theory.** Chamis, C.C. (Union Carbide Corp., Cleveland, Ohio (USA). Carbon Products Div.). 1974. Contract AF 33(615)-3110. 30p. NTIS, PC A03/MF A01.

Prepared in cooperation with Case Western Univ., Cleveland, Ohio.

A unified, semiempirical micromechanics theory is described which relates the thermoelastic properties of the unidirectional, filamentary composite to the quantities and to the corresponding properties of its constituent materials. The theory treats the composite, the filaments and the matrix as being generally orthotropic, linearly elastic, and accounts for the effect of voids. It is based on the equivalent section concept, on parallel- and series connected elements and on the judicious incorporation of certain empirical factors, which reflect the particular fabrication process. Results are presented which demonstrate and verify application of this theory to boron, carbon and glass-filament epoxy-resin composites. Additional results are presented which exhibit the voids and in-situ matrix orthotropicity effects on the thermoelastic properties of the unidirectional composite. Finally, results are included for all the thermoelastic properties of boron, carbon and glass-filament epoxy-resin composites.

54856 (UCID—17454) **Philosophy for nondestructive testing of fiber composites.** Hamstad, M.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1977. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

A discussion of a nondestructive testing philosophy for fiber composites is presented. The position is taken that the nondestructive test indications must be quantitatively correlated to the required engineering performance properties of the composite article. The currently unknown defect strcture in many fiber composites is discussed with respect to nondestructive testing. A few examples from the literature of the above described quantitative nondestructive testing of fiber composites are presented from the fields of acoustic emission and ultrasonics.

POLYMERS AND PLASTICS

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 53869

DEGRADATION AND EROSION

54857 (SAND—76-9082) **Durability of structural adhesive bonds (a review).** DeLollis, N.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 29p. (CONF-770407—3). Dep. NTIS, PC A03/MF A01.

From 22. national SAMPE symposium/exhibition; San Diego, California, United States of America (USA) (26 Apr 1977).

Real time data have been compiled showing the durability of most of the high strength adhesive types used in structural assemblies. These include epoxies, nitrile/epoxies, epoxy/phenolics, nitrile/phenolics, acrylics and two elastomers: polysulfides and silicones. Various prebond surface treatments for aluminum were also evaluated. The exposure environments included shelf aging, marine, jungle, industrial environments and some accelerated and stressed conditions for comparison. These data indicate that the most durable adhesive for all conditions at temperatures as high as 350°F is the nitrile-modified phenolic. The polyamide cured epoxies (usually considered a general purpose type) performed very well for periods up to eleven years and under a wide variety of conditions. Nylon/epoxy adhesives did well on continuous exposure to 250°F and outdoor exposures but could not withstand conditions of high humidity and water immersion. Nitrile epoxies survived all environments acceptably except for marine climate and continuous immersion in water. Epoxy phenolics in the unstressed condition survived all environments acceptably except continuous exposure to 350°F. The polysulfide bond to aluminum did well in all environments. However, the bond to cold rolled steel corroded at the steel interface. The silicone bonds were cohesively weak but the bond to either aluminum or steel was not degraded by any of the environments. Applied stress definitely accelerated bond degradation and the examples of accelerated aging used were not as severe as long term aging. 11 tables.

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 54859

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 54859

54858 **Neutron scattering study of the charge-density wave transitions in 2H-$TaSe_2$ and 2H-$NbSe_2$.** Moncton, D.E.; Axe, J.D.; DiSalvo, F.J. (Physics Department, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., B;* **16**: No. 2, 801-819(15 Jul 1977).

We have used the triple-axis neutron-scattering technique to study 2H-$TaSe_2$ and 2H-$NbSe_2$, which undergo charge-density wave transitions at T_0 = 122.3 and = 33.5 K, respectively. The transitions in both compounds appear to be second-order and involve atomic displacements of Σ_1 symmetry. At inception, the superlattices in both compounds have nearly identical incommensurate wave vectors with magnitude q/sub delta/ = 1/3(1-δ) a*, with $\delta \sim 0.02$. The $NbSe_2$ superlattice remains incommensurate to 5 K, but $TaSe_2$ undergoes a first-order lock-in transition where δ yields 0 at 90 K. The temperature dependence of the superlattice wave vector q in the incommensurate phase and the lock-in transition are discussed using a free energy involving third-order "umklapp" terms and a secondary order parameter. The secondary lattice distortion which is predicted in this model is observed experimentally. Most phonon branches having energies less than 10 meV with propagation vectors in the [zeta00] and [00zeta] directions have been measured at 300 K. Strong anomalies are found in the Σ_1[zeta00] phonon branches in both materials near the wave vector q/sub c/ = (1/3, 0, 0) characteristic of the low-temperature superlattices. Substantial softening of this phonon is observed as the transition is approached. In addition, the spectral profile exhibits a central peak which is not measurably inelastic.

PROPERTIES

REFER ALSO TO CITATION(S) 53702, 53851, 54719

54859 (AD-A—038685) **Characterization of the dynamic behavior of porous solids. Volume 7. Microstructural characterization of several porous ceramics and porous beryllium. Final rept 14 Jan 74-31 Jan 76.** Shockey, D.A.; Ginsberg, M.J.; Wilhelm, J.P.; Curran, D.R. (Stanford Research Inst., Menlo Park, Calif. (USA)). Mar 1976. Contract DNA001-74-C-0150. 34p. NTIS PCA03/MF A01.

See also Volume 4, AD-A—038686.

Porous sintered alumina, flame-sprayed alumina, plasma-sprayed aluminum titanate, plasma-sprayed hafnium titanate, and plasma-sprayed distended beryllium were used in the high explosive, gas gun and electron beam experiments reported in Volumes 4, 5 and 6 in this series. This report, Volume 7, describes the fabrication process, the microstructural characteristics, and the important chemical, physical and mechanical properties of each material.

54860 (COO—4056-3) **Development of ferromagnetic spinels for optical isolation at 10.6 μm. Progress report, August 1, 1976—April 30, 1977.** Teegarden, K.J. (Rochester Univ., N.Y. (USA)). Apr 1977. Contract EY-76-S-02-4056. 17p. Dep. NTIS, PC A02/MF A01.

The absorption coefficient, α, of $CdCr_2S_4$ crystals was measured at 10.6 μm and correlated with growth parameters. The best result to date was $\alpha = 15.5\ cm^{-1}$. An analysis of the intrinsic absorption of $CdCr_2S_4$ at 10.6 μm was made indicating a lower limit to α of $10^{-4}\ cm^{-1}$. Measurements of α vs. lambda in hot pressed disks of $CdCr_2S_4$ reveal that the most probable impurity affecting α at 10.6 μm is SO_4.

54861 (GA-A—14269) **Strength testing of production grade H-451 graphite; lots 472, 478, and 482.** Engle, G.B.; Price, R.J. (General Atomic Co., San Diego, Calif. (USA)). Mar 1977. Contract EY-76-03-0167-PRJ-17. 99p. Dep. NTIS, PC A05/MF A01.

Ninety-eight production logs of H-451 graphite, from three separate extrusion lots, were sampled for tensile testing. Eight replicate axial specimens from the midlength center and four replicate radial specimens from the end center of each log were tested. The axial strengths (average value 12.7 MPa) showed wide lot-to-lot and log-to-log variations, while the radial strengths (average value 15.8 MPa) were more uniform. Statistically based acceptance criteria which could be used for assigning a log to a minimum strength category were derived for two alternative definitions of "minimum" strength. The first definition would require 90 percent of the material at the midlength center of the log to exceed the specified minimum strength, with 90 percent confidence (90/90); the second, more stringent, definition would require 99 percent of the material to exceed the specified minimum, with 95 percent confidence (99/95). If three minimum strength categories are assumed, with category A requiring a minimum strength of 10.3 MPa, category B requiring 8.3 MPa, and category C requiring 5.5 MPa, use of the 90/90 definition of minimum strength would cause the rejection of two logs. Use of the 99/95 definition of minimum strength would increase the number of rejected logs to 18; however, this would include only 2 out of the 56 logs in the best extrusion lot. Decreasing the number of tests per log from eight to four would cause only small differences in the yields of logs accepted in each category.

54862 **Phonon scattering in amorphous solids.** Pohl, R.O. (Cornell Univ., Ithaca, NY). pp 107-114 of In Phonon scattering in solids. Challis, L.J.; Rampton, V.W.; Wyatt, A.F.G. (eds.). New York; Plenum Publishing Corporation (1976).

The thermal conductivity of all amorphous dielectric solids appears to depend only on the temperature and not on the material (to within a factor of ten). Studies undertaken to investigate this fact are reviewed. Although the phonon scattering responsible for the apparently universal low-temperature thermal conductivity of glasses has been very thoroughly studied through ultrasonic techniques, no independent evidence for the centers causing the scattering has been found. The frequently quoted low-temperature linear specific heat anomaly, in particular, must be viewed with caution at this time. The density of states derived from it must be regarded only as an upper limit of the scattering state. 5 figures. (RWR)

54863 **Thermal insulation behavior of closely packed fibre insulants at high temperatures and high pressures.** Broeckerhoff, P.; Scholz, F. (Kernforschungsanlage, Juelich, Ger.). *Verfahrenstechnik (Mainz);* **11**: No. 4, 237-240(Apr 1977). (In German).

Hot gas piping of gas-cooled reactors are particularly critical, since they have to feed hot gases at temperatures up to 950°C and at pressures of 40 to 60 bar. Since commercially available materials cannot be used under such conditions, it is necessary to insulate the pipes internally. Various methods are in use. One uses closely packed fibre materials. The paper describes two methods which are akin to each other, and measurements in air and helium at temperatures up to 760°C and pressures up to 40 bars are discussed. A short comparison is given with metal foil insulants employed earlier.

54864 **Multiphonon relaxation of rare-earth ions in oxide glasses.** Layne, C.B.; Lowdermilk, W.H.; Weber, M.J. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., B;* **16**: No. 1, 10-20(1 Jul 1977).

Nonradiative decay of excited rare-earth ions by multiphonon emission has been investigated in a series of oxide glasses. Various rare-earth electronic levels were selectively excited by short-duration laser pulses and multiphonon relaxation rates were determined from measurements of fluorescence rise and decay times. Time resolution for fluorescence measurements was 3 nsec, so excited states were probed for which the decay was predominantly nonradiative. Excited states of Nd^{3+}, Er^{3+}, and Tm^{3+} with energy gaps to the next-lower J state ranging from 1300 to 4700 cm^{-1} were studied. The multiphonon relaxation rates for each glass investigated exhibited an approximately exponential dependence on energy gap. Evidence of breakdown of this dependence was observed in the region of small energy gaps. The measured temperature dependences of the decay rates establish that the relaxation occurs predominantly by excitation of the highest-frequency vibrations associated with stretching modes of the glass network former. Borate, silicate, phosphate, germanate, and tellurite glasses were studied. From Raman spectra, the highest-frequency vibrations for these glasses ranged from 700 to 1400 cm^{-1}. The corresponding multiphonon relaxation rates for a given energy gap differed by three orders of magnitude. The strength of the ion-phonon coupling was found to be approximately equal for all glasses.

54865 **NMR of nuclei near rare-earth ions in yttrium ethyl sulfate.** Wolfe, J.P. (Department of Physics, University of California at Berkeley, Berkeley, California 94720). *Phys. Rev., B;* **16**: No. 1, 128-145(1 Jul 1977).

Nuclear magnetic resonances are detected for protons adjacent to rare-earth impurities in yttrium ethyl sulfate (YES) crystals at $T < 4.2$ K. The near-proton resonances are shifted several hundred gauss away from the usual bulk proton NMR and are two to four orders of magnetude weaker, depending on the impurity concentration. A sensitive and versatile rf spectrometer used to detect these weak signals is described in detail. The magnitude of the NMR shift is shown to be approximately described by a point dipolar field of the paramagnetic impurity, even for protons only 3 A from the impurity. However, field-angle dependences of these nearest proton splittings reveal significant deviations from the simple dipolar interaction which most likely arise from the finite extent of the impurity wave function. A frequency dependence of the splitting gives the components of the local field parallel and perpendicular to the external field direction. The intensities of the near-nuclei magnetic resonances (NNMR) in YES:Yb decrease rapidly above 3.8 K. The observed temperature dependence is quantitatively explained for 1.5 K < T < 4.2 K by including time-dependent fluctuations in the local field. A general NNMR criterion is experimentally established: lifetime broadening of the near-nuclei resonances occurs whenever the electron <S/sub z/< (t) correlation time tau is shorter than the inverse dipolar NMR linewidth; i.e., when tau is less than about 10^{-5} sec for abundant ^1H and ^{19}F spins. From the near proton splittings in YES:Yb near $\theta = 90°$, a large distribution in the value of the elusive g/sub perpendicular/ factor was discovered, giving g-bar/sub perpendicular/ = 0.01. Comparisons of NNMR spectra for several rare-earth ions in YES and the extension of this method to other crystals are discussed.

54866 **Critical behavior of pure and site-random two-dimensional antiferromagnets.** Birgeneau, R.J.; Als-Nielsen, J.; Shirane, G. (Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., B;* **16**: No. 1, 280-292(1 Jul 1977).

Quasielastic neutron-scattering studies of the static critical behavior in the two-dimensional antiferromagnets K_2NiF_4, K_2MnF_4, and $Rb_2Mn.T_5Ni_{0.5}$ F_4 are reported. For T < 0.95T/sub N/ the diffuse scattering arises principally from the noncritical transverse susceptibility chi/sup perpendicular/(Q). In all three materials chi/sup perpendicular/(Q) is found to be only weakly temperature dependent for T < T/sub N/ with a halfwidth κ/sup perpendicular/ consistent with spin-wave theory. For abs. value - T/T/sub N/ < 0.05 the overall scattering is dominated by the critical Ising component chi/sup parallel/(Q). The total scattering is proportional to chi/sup parallel/(Q) + chi/sup perpendicular/(Q) so that, with an appropriate correction for chi/sup perpendicular/(Q), the detailed critical behavior for chi/sup parallel/(Q) may be determined. For the reduced temperature range 0.008 < T/T/sub N/ - 1 < 0.15 one finds in all three materials $\nu = 0.9 \pm 0.1$, $\gamma = 1.6 \pm 0.15$, and from the scaling relation $\gamma = \nu(2 - eta)$, eta = 0.2 +- 0.05. For T < T/sub N/ one finds $\beta = 0.15 \pm 0.015$ in the three systems. Finally, in K_2NiF_4 for T < T/sub N/, chi/sup parallel/(0), and κ/sup parallel/ are consistent with two-dimensional Ising behavior with exponents $\gamma' = 1.75$, $\nu' = 1$; further chi/sup parallel/(+ abs. value epsilon) (50 +- 10) chi/sup parallel/(- abs. value epsilon) compared with the Ising asymmetry factor of 37. These results thus demonstrate that the site-random and pure systems have identical

critical behavior in agreement with current theory. Further, the critical behavior is close to that of the two-dimensional Ising model, although there are small differences, assumedly due to the fact that the experiments do not probe the true asymptotic region. Finally a number of inconsistencies in earlier experiments are resolved.

54867 Oscillatory magnetotransport in the layer compounds 4Hb-TaS_2 and 2H-$TaSe_2$. Fleming, R.M.; Coleman, R.V. (Department of Physics, University of Virginia, Charlottesville, Virginia 22901). *Phys. Rev., B;* **16**: No. 1, 302-315(1 Jul 1977).

Quantum oscillations have been observed in the magnetoresistance and Hall effect of 4Hb-TaS_2 and 2H-$TaSe_2$ in fields up to 230 kG. For magnetic fields perpendicular to the layers at least twelve frequencies in the range 0.044 to 8.2 MG have been observed in 4Hb-TaS_2. Eleven frequencies in the range 1.6 to 44.6 MG have been observed in 2H-$TaSe_2$. The angular dependence of the frequencies generally follows functions of the form ω/sub perpendicular//sinθ, where ω/sub perpendicular/ is the frequency observed for field perpendicular to the layers and θ is the angle between the field and the layers. The angular dependence is consistent with that expected for a nearly-two-dimensional cylindrical Fermi surface, and the small cross sections corresponding to the observed frequencies indicate that the Fermi-surface sections result from the $3a_0 \times 3a_0 \times c_0$ charge-density-wave superlattice. Maxima in the magnetoresistance rotation diagrams indicate the presence of open orbits along the c axis in both materials. Features in the field dependence of the magnetoresistance and Hall effect of 4Hb-TaS_2 suggest the presence of magnetic breakdown while the field dependence observed in 2H-$TaSe_2$ is well behaved, although magnetic breakdown may play a role in the orbits associated with the highest frequencies.

54868 Interatomic Auger processes in NaCl. Yafet, Y.; Watson, R.E. (Bell Laboratories, Murray Hill, New Jersey 07974). *Phys. Rev., B;* **16**: No. 2, 895-899(15 Jul 1977).

The decay rate of a Na 2s hole in NaCl by interatomic Auger transitions associated with a valence electron located on the nearest-neighbor chlorines is calculated. The Cl orbitals of the octahedral cluster surrounding the Na 2s vacancy are combined into molecular orbitals and the Auger transitions to spherical waves having $l <$ or $= 4$ are determined. The total calculated rate is nearly twice that calculated for the 2s vacancy in a free Na atom and supports the earlier suggestion by Citrin that the effective valence charge on the Na^+ ion due to the ligand orbitals is even larger in NaCl than it is in the free atom.

CORROSION, EROSION, AND DEGRADATION

REFER ALSO TO CITATION(S) 54611, 54612, 54613, 54614

54869 Stimulated emission from thin PbSe films at room temperature. Galeski, F.; Drozd, I.A.; Lebedeva, L.Y.; Ten, V.P.; Yunovich, A.E. (M. V. Lomonosov State University, Moscow). *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 3, 327-328(Mar 1977).

Films of PbSe prepared by evaporation in the presence of excess Se emitted stimulated photoluminescence of $1<4\mu$ wavelengths at temperatures up to 330degreeK.(AIP)

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 54829

54870 Radiation and temperature-induced changes in the width and intensity of the Raman spectral lines of α-quartz. Zubov, V.G.; Osipova, L.P. (M. V. Lomonosov Moscow State University). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 1, 61-64(Jan 1977).

It is shown that the width of the 128, 206, 357, 466, 696, and 1159 cm^{-1} Raman lines of α-quartz increases both on irradiating the quartz with fast neutrons and also on heating the crystals. For the 206 cm^{-1} line the temperature and radiation dependences of the linewidth are very similar; for the 128, 357, 466, and 1159 cm^{-1} lines radiation leads to a greater broadening than heating to the temperature corresponding to the flux in question. The greater broadening of the Raman spectral lines of quartz on irradiation with fast neutrons is attributed to amorphization. A comparison between the behavior of the 128, 206, and 466 cm^{-1} line intensities after reactor irradiation and heating the crystals shows that the change in the 206 cm^{-1} line intensity due to irradiation is analogous to that due to temperature, whereas anomalous behavior is encountered in the case of the 128 and 466 cm^{-1} lines. In order to explain the radiation dependence of the 128, 206, and 466 cm^{-1} lines (and the temperature dependence of the 206 cm^{-1} line), it is sufficient to allow for the anharmonicity of the lattice vibrations of the irradiated crystals, due to the formation of radiation defects.

54871 X-ray diffraction in silicon crystals irradiated with boron ions. Baturin, V.E.; Koval'chuk, M.V.; Kov'ev, E.K.; Palapis, V.E. (Institute of Crystallography, Academy of Sciences of the USSR). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 1, 79-82(Jan 1977).

X-ray diffraction in perfect silicon crystals irradiated with 40 keV boron ions is analyzed. The "tails" of the diffraction curves contain weak oscillations in the reflection coefficient. This effect is attributed to interference between waves scattered by a thin layer having a linear variation in lattice constant and the main part of the crystal.

CHEMISTRY

54872 (PB—265544) Bibliography of investment costs, operating costs, and related economic information for the mineral industries, January-December 1975. Information circular. Sabatini, J.; Conley, L.A. (Bureau of Mines, Morgantown, W.Va. (USA). Process Evaluation Group). Sep 1976. 64p. (BM-IC—8716). NTIS, PC A04/MF A01.

This report, covering the period January through December 1975, contains abstracts of articles concerning all phases of cost engineering and economics for chemicals processing, mining, and other mineral industries. The bibliography has a major emphasis on energy-related activities, and many abstracts give investment and operating costs for synthetic fuel plants, oil and gas exploration and production, underground and surface coal mining and reclamation, and nuclear and conventional power generation facilities. Some other subjects covered included cost estimating methods and theory, reports on construction projects in the United States and abroad, developments in the environmental control segment of the energy economy, progress in solar and geothermal energy development, deep ocean mining, and logistics in the energy market.

54873 173rd national meeting of the American Chemical Society. Abstracts of papers. Washington, DC; American Chemical Society (1977). vp. (CONF-770301—(Absts.)).

From 173. national meeting of the American Chemical Society; New Orleans, Louisiana, United States of America (USA) (20 Mar 1977).

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 54013, 55083, 55084, 55087

54874 (INIS-mf—3590) Trace elements 75. Seminar proceedings. (Ceskoslovenska Akademie Ved, Prague. Ceskoslovenska Spolecnost Chemicka). 1975. vp. (CONF-7504134—). NTIS.

From 9. seminar on the methods of determination and on significance of trace elements in biological materials; Prague, Czechoslovakia (15 Apr 1975).

Separate abstracts of individual papers were entered into the data base. (DLC)

54875 Phased approach to environmental assessment sampling and analysis. Dorsey, J.A.; Statnick, R.M.; Lochmuller, C.H. (Environmental Protection Agency, Research Triangle Park, NC). pp 545-548 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976).

See CONF-761016—.

There are two distinct approaches to an environmental source assessment sampling strategy which would satisfy the goals outlined. The first approach which we are calling the "direct approach" would subject each stream to a complete and detailed sampling and analytical program on the first sampling trip. This methodology would use state-of-the-art sampling procedures and state-of-the-art analytical procedures to characterize the emissions potential of each sampled stream. The second approach which we are calling the phased approach consists of a series of sampling and analytical activities which first characterizes the emissions and prioritize the streams (or stream components); secondly, provides a detailed characterization of those streams which have received a high priority; and thirdly, provides for the continual monitoring of selected surrogates to determine the influence of process variations on the emission rate. Since both the direct and the phased approaches to an environmental source assessment offer, at least in principle, equal promise of success, the relative resource requirements of each sampling and analysis strategy was examined for a full-scale Lurgi gasification complex and for a pilot scale limestone wet scrubbing process. A comparison of the total estimated costs for both processes by both sampling and analysis strategies is given. In both cases, the phased approach was more cost effective than the direct approach.

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 55086

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 53682, 54050, 55080

54876 Cathodic pulse stripping analysis of iodine at the parts-per-billion level. Propst, R.C. (E. I. du Pont de Nemours and Co., Aiken, SC). *Anal. Chem.;* **49**: No. 8, 1199-1205(Jul 1977).

The deposition-stripping behavior of iodide films at the hanging mercury drop electrode (HMDE) is investigated. Surface monolayers of Hg . HgI and Hg_2I_2 are postulated based on the percentage occupancy of the available sites at the surface of the HMDE. Submonolayer films of Hg . HgI, as stripped from the electrode, are used to determine iodine concentrations from 1 to 50 ppb with a standard deviation of 0.3 ppb.

54877 Equivalence-point determinations for automated potentiometric titrations with ion-selective electrodes. Frazer, J.W.; Selig, W.; Rigdon, L.P. (Univ. of California, Livermore). *Anal. Chem.;* **49**: No. 8, 1250-1255(Jul 1977).

An improved method is presented for determining the equivalence point in potentiometric titrations. Titration rate and data acquisition are under computer control, and ion-selective electrodes are used as indicators. As the titration proceeds, the potentiometric curve and Gran (antilog) plot are displayed on a CRT. Upon completion of the titration, the operator uses interactive graphic techniques to interrogate the Gran plot and develop an error function. This error function identifies the period during the potentiometric titration when the cell output is most nearly Nernstian. Data obtained during the identified period are used to estimate the equivalence point. Data are presented together with a discussion of the characteristic features of the error function.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

54878 (AD-A—038910) **Isotopic analysis of low-activity plutonium samples using high-resolution alpha and photon spectroscopy.** Strickland, J.L. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio (USA). School of Engineering). Dec 1976. 85p. (AFIT/GNE/PH—76D-7). NTIS PCA05/MF A01.

Thesis.

High-resolution alpha particle and photon spectroscopy is applied to determining the ratios of ^{239}Pu and ^{240}Pu in isotopically mixed samples of less than a few thousand DPM. The utility of alpha-gamma coincidence and L-shell x-ray spectroscopy methods are explored. Experimental equipment, procedures and calibration methods are discussed. Minimum sample activities necessary for quantification are presented for each method. Instrumental and statistical uncertainties prevented reliable determination of isotopic ratios. Improvements in equipment are recommended to reduce uncertainties.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 53698, 53924, 53996, 54891, 55052, 55186

54879 (AD-A—038838) **Spectrochemical analysis of boron carbide by powder techniques. Final report.** Strauss, B.H.; Howell, F.G. (Army Materials and Mechanics Research Center, Watertown, Mass. (USA)). Feb 1977. 12p. (AMMRC-TR—77-6). NTIS PCA02/MF A01.

A method for the determination of impurities in boron carbide was developed using powder techniques. The elements aluminum, calcium, iron, magnesium, manganese, nickel, silicon, titanium, and vanadium were determined over concentration ranges between 10 and 24,000 parts per million. The boron carbide powder was mixed with buffers including an internal standard. These sample mixtures were excited in a direct current arc and spectra were recorded on photographic plates. Due to a lack of standard boron carbide samples, the analytical curves are based on the wet chemical analysis of six samples. Dilution with graphite was employed to extend the analytical curves of the higher levels elements (aluminum, calcium, iron, and silicon) down to 100 ppm or less.

54880 Environmental and fuel materials analyses by multi-element isotope dilution spark-source mass spectrometry. Carter, J.A.; Donohue, D.L.; Franklin, J.C.; Stelzner, R.W. (Oak Ridge National Lab., TN). pp 303-310 of In Trace substances in environmental health. Vol. IX. Hemphill, D.D. (ed.). Columbia, MO; Univ. of Missouri (1975).

The isotope dilution method of analysis has been expanded to allow the addition of 20 or more enriched stable isotopes to a single sample. The method combines the survey capability of spark-source mass spectrometry with the accuracy and precision of isotope dilution techniques. The limit on the precision of analysis may well be the variability in response of the Ilford QII emulsion. The method has been studied using National Bureau of Standards reference materials in order to determine its accuracy and precision. The method has been used to measure impurities in a variety of environmental samples at several concentration ranges. A microphotometer has been interfaced with a mini-computer to permit rapid collection, of data and subsequent concentration determinations. The data system and its operation will be discussed briefly.

54881 Instant spectroscopy in the visible, ultraviolet, and vacuum ultraviolet with Polaroid film. Engleman, R. Jr.; Radziemski, L.J. Jr. (Los Alamos Scientific Lab., NM). *Appl. Opt.;* **14**: No. 12, 2821-2822(Dec 1975).

Results of tests performed with Polaroid type 75 positive film for recording spectra in the visible, ultraviolet, and vacuum ultraviolet are reported. The film is reported to be very satisfactory for checking alignment of spectrographs and for diagnostic purposes while preparing experiments. A method for sensitizing the film for use in vacuum ultraviolet work is described. (BLM)

54882 New cross sections for the absorption of near ultraviolet radiation by nitrous oxide (N_2O). Johnston, H.S.; Selwyn, G.S. (Univ. of California, Berkeley). *Geophys. Res. Lett.;* **2**: No. 12, 549-551(Dec 1975).

A re-investigation of the ultraviolet absorption spectrum of nitrous oxide (N_2O) agrees with previous results in the range 210 to 235 nm, but contrary to previous results it indicates a vanishingly small cross section above 260 nm. The absence of the relatively long wave length absorption implies a negligible rate of photolysis of nitrous oxide in the troposphere. These results plus the previously estimated atmospheric mean residence times of N_2O indicate that there is a large, unknown tropospheric sink for nitrous oxide.

54883 Use of yttrium and sodium anodes in photoelectron spectroscopy. Banna, M.S.; Shirley, D.A. (Univ. of California, Berkeley). *J. Electron Spectrosc. Relat. Phenom.;* **8**: 23-34(1976).

Low-cost anodes of the active metals yttrium and sodium were constructed and used under modest vacuum conditions. The yttrium Mzeta line (132.3 eV) was used to determine np/ns cross-section ratios in the valence shells of three rare gases. The $NaK\alpha_{12}$ line and its satellites were characterized with a neon converter. It yielded a linewidth of 0.58(1) eV on the neon 1s line, from which an upper limit of 0.42 eV was set for the $NaK\alpha_{12}$ x-ray linewidth. On several "test cases" the $NaK\alpha_{12}$ x-ray fell between other characteristic x-rays (e.g., $MgK\alpha_{12}$) and monochromatized sources in its ability to resolve fine structure. The methane C 1s peak was asymmetric and the correct vibrational spacing was obtained by fitting with three components of the correct intensity ratios. Similarly, relative chemical shifts of the unsubstituted carbons in m-difluorobenzene were determined almost completely by fitting the asymmetric peak. In the PF_5 (F1s) and O_2 (O 1s) cases some new information was obtained.

54884 Absorption coefficients of sulfur dioxide microwave rotational lines. Kolbe, W.F.; Leskovar, B.; Buscher, H. (Univ. of California, Berkeley). *J. Mol. Spectrosc.;* **59**: 86-95(1976).

New calculations of the absorption coefficients of the rotational transitions of $^{32}S^{16}O_2$ are given for all energy levels up to J = 50 and frequencies less than 200 GHz. A spectrometer incorporating a semiconfocal Fabry-Perot resonant cavity and operating in the vicinity of 70 GHz is described. The calculated absorption coefficients are compared to measured values obtained with this spectrometer and to existing measurements over the frequency range 26 to 40 GHz. The results obtained are in general agreement to within 5 to 10 percent.

54885 Quantitation of manganese(II) ion binding to dissolved yellow organic substances of natural waters by electron spin resonance. Gaver, R.W.; Milanovich, F.P.; Ward, R.L. (Univ. of California, Livermore). *J. Environ. Sci. Health, Part A;* **11**: No. 12, 743-754(1976).

The electron spin resonance technique for determining free manganese(II) ion concentration in aqueous solution has been applied to the study of divalent ion binding by polyanions such as the dissolved yellow organic substances found in surface water sources. Using this technique it was shown that 769 grams of dissolved yellow organic substance from Alameda Creek, Sunol Regional Park (California) are required to bind one mole of manganese(II) ion, and the weight basis formation constant is 161 $(g/l)^{-1}$.

54886 Angular-resolved Auger emission spectra from a clean Cu(100) surface. Noonan, J.R.; Zehner, D.M.; Jenkins, L.H. (Oak Ridge National Lab., TN). *J. Vac. Sci. Technol.;* **13**: No. 1, 183-187(1976).

Previous measurements of the angular emission of Auger electrons from a clean Cu(110) surface, using a Faraday cup retarding-field analyzer, have revealed large intensity variations as a function of either polar or azimuthal angle. Additional measurements

of the angular Auger electron emission for both the 62-eV $M_{2,3}VV$ and 107-eV M_1VV transitions from the Cu(100) surface which exhibit variations of similar magnitude are reported. Some of these data are compared with similar observations by McDonnell, Woodruff, and Holland and with results of their single-scattering diffraction calculation. The effects of variation of incident beam energy and angle also have been investigated and these data are presented and discussed.

54887 Scattered light effects in photoacoustic spectroscopy. McClelland, J.F.; Kniseley, R.N. (Ames Lab., IA). *Appl. Opt.;* **15**: No. 12, 2967-2968(Dec 1976).

A scattered light contribution to the photoacoustic signal is reported. The scattered light component was observed with a liquid dye sample in various configurations. A method for reducing this spurious effect is presented. (BLM)

54888 Mass spectrometric determination of zirconium from a resin bead. Walker, R.L.; Botts, J.L.; Carter, J.A.; Costanzo, D.A. (Oak Ridge National Lab., TN). *Anal. Lett.;* **10**: No. 4, 251-262(1977).

A sensitive, isotope dilution technique has been developed for the analysis of sub-microgram amounts of zirconium. The analysis is based on the increased thermal ion emission for Zr adsorbed on a single anion resin bead. Zr is isolated from a solution containing the sample and a highly enriched ^{94}Zr (96%) spike. The determination is made possible by using a high-sensitivity pulse-counting 2-stage 30-cm radius mass spectrometer. The detection limit depends upon the amount of the isotope spike added and the desired precision. Fifty nanograms of zirconium (sample plus spike) produce sufficient ion signals for reliable isotopic analysis so that fission Zr can be measured with blank correction to a precision of 3%. By this method for fission Zr in spent reactor fuel particles, contamination from normal Zr and Mo can be corrected out by making isotopic measurements before and after spiking and scanning masses 90 and 95 during analysis. Since neither masses 90 nor 95 are stable fission products, their presence is due to sample contamination and can be used for correction based on their normal isotopic distributions. Zone-refined tantalum ribbon, essentially free of normal Zr and Mo was selected as the ionizing filament. This method can be adapted to a wide variety of samples.

54889 Photoelectron spectroscopy of carbonyls. 1,4-benzoquinones. Dougherty, D.; McGlynn, S.P. (Louisiana State Univ., Baton Rouge). *J. Am. Chem. Soc.;* **99**: No. 10, 3234-3239(11 May 1977).

He I photoelectron spectra have been obtained for 1,4-benzoquinone (PBQ) and some selected derivatives. A correlative study, which is based on the vibronic characteristics of the various ionization events and on the differential sensitivities of these events to chemical substitution (usually methylation, fluorination, or chlorination) on the benzenoid ring, leads to an MO assignment for the low-energy ionization regime. The assignment for PBQ, in order of decreasing MO energy, is n/sub -/ < n/sub +/ < π/sub circled +/ < π/sub -/; that for tetrafluoro-1,4-benzoquinone (TFPBQ) is n/sub +/ < n/sub -/ < π/sub -/ < π/sub circled +/. The perfluoro effect on PBQ induces shifts of the n orbitals which are ~1 eV. The perfluoro shifts of the π orbitals are somewhat smaller than those of the n orbitals. CNDO/2 computations provide uniformly poor agreement with the experimental data and retain no assignment utility unless used in a perturbative sense.

SEPARATION PROCEDURES

54890 Supercritical fluid chromatography applied to the characterization of a siloxane-based gas chromatographic stationary phase. Nieman, J.A.; Rogers, L.B. (Purdue Univ., West Lafayette, IN). *Sep. Sci.;* **10**: No. 5, 517-545(1975).

Supercritical fluid chromatography using n-pentane as a mobile phase and Porasil C as a column packing was applied to the characterization of Dow-Corning 710 fluid, a gas chromatographic stationary phase. Decomposition of the polymer was observed on columns of alumina, and derivatized Porasil packings were found to be unstable. Linear pressure programming variables were studied at 206 and 216°C by normalizing the total analysis time on a fixed length of column. A series of homologous polymer components was used to demonstrate the effects upon resolution of density-isotherm nonlinearity associated with the mobile phase. The results showed that optimal temperature conditions existed for the use of linear pressure programming, with the choice of temperature conditions dependent upon the molecular weight range. Operational guidelines are suggested. Mixed solvent behavior was investigated for this separation. Addition of 0 to 20 percent v/v isopropanol to pentane was shown to change adsorption characteristics and alter critical constants. The effect upon the critical constants appeared to conform to Kay's approximation. The results suggest that mixed solvents can be used to speed up separations for mixtures having components of widely different adsorption energies. The pseudocritical concept using Kay's approximation was tested for its qualitative ability to estimate state effects when solvents are mixed. The effect of temperature upon migration behavior was compared for equimolar amounts of isopropanol and methanol, each in n-pentane. Kay's approximation appeared to be useful for qualitative predictions regarding changes in critical pressure. However, an attempt to predict density isotherm behavior for 20% isopropanol in n-pentane relative to pure n-pentane suggested that Kay's approximation may not be as useful for predicting critical temperature effects.

54891 Separation method for coal-derived solids and heavy liquids. Schiller, J.E.; Mathiason, D.R. (Grand Forks Energy Research Center, ND). *Anal. Chem.;* **49**: No. 8, 1225-1228(Jul 1977).

A rapid, simple chromatographic procedure has been developed to fractionate coal-derived solids and liquids for subsequent analysis by mass spectrometry and other spectral methods. The sample is pre-adsorbed on neutral alumina (activity I), and eluted with hexane, toluene, chloroform (2 fractions) and 9:1 tetrahydrofuran-ethanol. The principal compound types eluted in each fraction, respectively, are: saturated hydrocarbons, aromatic hydrocarbons and benzofurans, ethers, nitrogen compounds, and hydroxyl compounds. Mass spectral analysis is enhanced because the toluene eluate contains only aromatic hydrocarbons and ethers, while the second chloroform fraction includes almost all of the nitrogen compounds in the sample.

INORGANIC AND PHYSICAL CHEMISTRY

54892 (AD-A—038665) Far infrared study of cation motion in dry and solvated mono- and divalent zeolites x and y. Technical report. Butler, W.M.; Angell, C.L.; McAllister, W.; Risen, W.M. Jr. (Brown Univ., Providence, R.I. (USA). Dept. of Chemistry). 10 Mar 1977. Contract N00014-75-C-0883. 45p. NTIS PCA03/MF A01.

Far infrared ion motion bands have been observed and assigned in the spectra of dry synthetic zeolites X and Y containing Li^+, Na^+, K^+, Rb^+, Cs^+, Ag^+, Ca^{2+}, Sr^{2+}, and Ba^{2+} cations. The site I' and site II cation vibrational bands overlap and form the strongest feature in the spectra of samples exchanged with monovalent ions. The site I cation band appears at lower frequency than the site II envelope in these samples, but in divalent ion exchanged zeolites the opposite order occurs. A very low frequency site III cation band, typical of monovalent X zeolites, has been observed in CsY. For a given cation, the frequency on X is higher than on Y due to the higher framework charge of X zeolites. The vibrational frequencies also follow an approximate m raised to minus 1/2 power dependence for the two types of cation and the two forms of the zeolite. Solvation of the monovalent zeolites with H_2O, THF, DMSO, pyridine, and CH_2Cl_2 results in the appearance of a new band at higher frequency than the ion-framework modes which concurrently diminish in intensity, especially the site III band. The high frequency band is due to ion motion in a solvation shell which is unsymmetric at low hydration levels and at all solvation levels with organic adsorbates.

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 53663, 54840

54893 (AD-A—038664) Mixed alkali glass spectra and structure. Technical report. Rouse, G.B.; Miller, P.; Risen, W.M. Jr. (Brown Univ., Providence, R.I. (USA). Dept. of Chemistry). 10 Mar 1977. Contract N00014-75-C-0883. 34p. NTIS PCA03/MF A01.

The far infrared and Raman spectra of several series of mixed alkali metaphosphate glasses have been investigated as a function of the mole fraction, x, of the network modifying ionic oxides in $xM_2O(1-x)M_2O.P_2O_5$. The frequencies of the cation-motion bands in the far infrared spectra, which correspond to cation-site vibrations, do not shift with x, indicating that the vibrationally significant local geometry and forces associated with a particular cation are unaffected by the introduction of the second cation into the glass structure. Each Raman-active band due to vibrations of the metaphosphate network occurs at a different frequency for each pure glass (x-0 or 1), but for mixed alkali glasses only one band occurs for each type of mode and it varies linearly with x. This indicates that the cations in these mixed alkali glasses are homogeneously distributed, there is no significant molecular-level domain formation, and the phosphate chains are associated with an averaged cation environment whose effect on the chain modes varies with x. A simple vibrational model is presented which shows that the cation-dependent shifts are due to small changes in network bond angles and variation of the cation-site forces.

54894 (AD-A—039001) HTFFR kinetics studies of Al + Co_2 yields of A10 + CO from 300 to 1800°K, a non-arrhenius reaction. Technical report. Fontijn, A.; Felder, W. (Purdue Univ., Lafayette, Ind. (USA). Project Squid Headquarters). Apr 1977. Contract N00014-75-C-1143. 36p. (SQUID-AC—16-PU). NTIS PCA03/MF A01.

Prepared in cooperation with AeroChem Research Labs., Inc., Princeton, N. J. Rept. no. AeroChem-TP-353.

The previously described metal atom oxidation studies using a high-temperature fast-flow reactor (HTFFR) which, in its various modifications, allows the measurement of rate coefficients of reactions over roughly the 300-2000 K temperature range. The earlier HTFFR measurements covered most of this range for Al/O2 and AlO/O2 reactions. The rate coefficients of both these reactions were found to be, within experimental error, temperature independent. In the present work we have studied the reaction Al + CO2 gives AlO + CO. This reaction was selected since, on the basis of the most commonly accepted bond energy of AlO, it is endothermic and hence has an activation energy, i.e., a temperature-dependent rate coefficient. The reaction has indeed been found here to have a positive activation energy, though evidence is discussed suggesting it may be somewhat more energetic than usually assumed.

54895 (UCRL—79374) **Effect of centrifuging on fluctuations in the critical liquid—liquid region.** Alder, B.J.; Alley, W.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1977. Contract W-7405-ENG-48. 13p. (CONF-770608—1). Dep. NTIS, PC A02/MF A01.

From 3. west coast statistical mechanics conference; San Jose, California, United States of America (USA) (14 Jun 1977).

A recent interpretation of the results of the shift of the critical temperature of two liquid pairs with centrifugal fields as a nonequilibrium sedimentation phenomenon is at variance with the experimental fact that once the phase boundary was formed, there was no further observable change with time at constant rotor speed. Furthermore, both systems behaved qualitatively the same, even though for the system where the pairs of liquids have nearly equal densities, the shift of the critical temperature can be accounted for by the equilibrium shift associated with the hydrostatic pressure developed by the centrifugal field. Although a centrifugal field cannot in general shift thermodynamic properties except for the barocentric effect mentioned above, near the critical point fluctuations and particularly gradients in the fluctuations can, if the densities of the pair differ greatly, be "stretched" by the centrifugal field which leads to a shift of critical temperature that is of the magnitude and the direction that is observed.

54896 Reactions of alkali ions with organic molecules in the gas phase. Low energy pathways for carbonium ion formation and novel methods for generating alkali ion complexes with π^- and n-donor bases. Wieting, R.D.; Staley, R.H.; Beauchamp, J.L. (California Inst. of Tech., Pasadena). *J. Am. Chem. Soc.;* 97: 924-926(1975).

In the study of reactivity of alkali ions with halogenated hydrocarbons, it was demonstrated that halide ion transfer reactions between carbonium ions are rapid and can be employed to determine R^+-X^- heterolytic bond energies. Bond energies for various organic and alkali chlorides and bromides are tabulated. These determinations of binding energies of alkali ions to π- and n-donor bases contribute to a better understanding of the general theories of acid-base interaction. (BLM)

54897 Apparent dissociation constants of hydrogen sulfide in chloride solutions. Goldhaber, M.B.; Kaplan, I.R. (Univ. of California, Los Angeles). *Mar. Chem.;* No. 3, 83-104(1975).

Spectrophotometric measurements are reported for the first apparent dissociation constant of hydrogen sulfide in seawater over the temperature range 7.5 to 25°C and 2 to 35.8‰ salinity. These data are described by the expression $pK'_1 = 2.527 - 0.169$ Cl/sup 1/ 3/ + 1359.96/T. The second apparent dissociation constant in potassium chloride solution was estimated potentiometrically using a sulfide specific ion electrode. A value of ~13.6 was found for pK'_2 at a KCl concentration of 0.67 M. It is suggested that explicit reference to the sulfide ion, S^{2-}, in describing equilibria in marine waters be dropped in favor of a formulation involving the bisulfide ion, HS^-.

54898 Kinetics and thermodynamics of decomposition of barium sulphate. Mohazzabi, P.; Searcy, A.W. (Univ. of California, Berkeley). *J. Chem. Soc. (London), Faraday Trans., I;* 72: 291-295(1976).

Equilibrium vapor pressures of barium sulphate and free surface sublimation pressures of single crystals were both measured for the first time, using torsion-effusion and torsion-Langmuir techniques, respectively. Mass spectrometer measurements showed the principal decomposition reaction to be $BaSO_4(s)$ yields $BaO(s) + SO_2(g) + \frac{1}{2}O_2(g)$ for both equilibrium and free surface conditions. The flux in the Langmuir experiments remained constant at about 10^{-2} times that for effusion of equilibrium gaseous products over the temperature range 1422 to 1540 K. Effusion of the product gases through the porous product layer does not reduce the reaction rate even when the product layer thickness is as great as 1 mm. The simplest model consistent with the data assumes that all steps of the reaction except desorption to the gaseous products are at equilibrium, but that desorption occurs from only 1 percent of the surface sites. The equilibrium studies yielded, for the crystal modification stable above 1422 K, $\Delta H/\text{sub } D/^\circ = 588.3 +— 6.7$ kJ mol^{-1} and $\Delta S^\circ/\text{sub } D/ = 257.3 +— 4.6$ jK^{-1} (mol $BaSO_4$)$^{-1}$. The kinetic studies yielded $\Delta H^*/\text{sub } D/ = 575.3 +— 12.6$ kJ mol^{-1} and $\Delta S^*/\text{sub } D/ = 200.4 +- 8.4$ JK^{-1} (mol $BaSO_4$])$^{-1}$ as the apparent enthalpy and entropy of activation for the decomposition reaction of the high temperature form of $BaSO_4$ when the activated state is assumed to consist of $SO_2(g) + \frac{1}{2}O_2(g)$ per mole of barium sulphate.

54899 Solution properties of some pentafluorides and oxide tetrafluorides in anhydrous hydrogen fluoride. Paine, R.T. (Los Alamos Scientific Lab., NM); Quarterman, L.A. *J. Inorg. Nucl. Chem.;* Supplement, 85-86(1976).

Solutions of transition metal pentafluorides, MF_5, M = Nb, Ta, Mo, Re and Os, and oxide tetrafluorides, MOF_4, M = Mo, W and Re, in anhydrous hydrogen fluoride have been prepared. The conductivity and Raman spectrum of the solutions have been recorded. The conductimetric measurements indicate that all the compounds are relatively weak fluoride ion acceptors; the order of Lewis acid strength is $OsF_5 < ReF_5 < TaF_5 < MoF_5 < NbF_5$ much greater than $ReOF_4 < WOF_4 < MoOF_4$. None of the solutions contained sufficient amounts of MF_6^- or MOF_5^- ions to detect by Raman spectroscopy. The data are discussed, together with similar existing data on other pentafluoride-hydrogen fluoride solutions.

54900 Some unusual dimeric and cluster species of the Group VI transition metals. McCarley, R.E.; Templeton, J.L.; Colburn, T.J.; Katovic, V.; Hoxmeier, R.J. (Ames Lab., IA). pp 318-334 of In Inorganic compounds with unusual properties. King, R.B. (ed.). Washington, DC; American Chemical Society (1976).

Several new compounds of molybdenum and tungsten that have multiple metal—metal bonds are described. It is concluded that the compounds $[Mo_2(O_2CR)_4]I_3$ (R = C_2H_5, $C(CH_3)_3$, or C_6H_5), formed by reaction of $Mo_2(O_2CR)_4$ with iodine in noncoordinating solvents, are I_5^- salts of the cations $(Mo_2(O_2CR)_4]^+$ with Mo—Mo bond order of 3.5. The first species containing quadruply bonded tungsten, $MoW(O_2C(CH_3)_3)_4$, was prepared in mixtures with $Mo_2(O_2CR)_4$ with which it is isostructural and isomorphous. The mixtures were separated by iodination in benzene, which provided $[MoW(O_2CC(CH_3)_3)_4]I$ containing the one-electron oxidized cation $[MoW(O_2CC[CH_3)_3)_4]^+$ with Mo—W bond order of 3.5. The compound $[(C_3H_7)_4N]_2W_2Br_8$, prepared by reaction between $[(C_2H_5)_4N]W(CO)_5Br$ and dibromoethane, contains the new confacial bioctahedral anion $W_2Br_8^{2-}$, d(W-W) = 2.58(1) A, and μ(exp.) = 1.72 BM. An unusual mixed halide complex $[(C_4H_9)_4N]_2Mo_4I_{10}Cl$ is also repoted.

54901 Bonding model for transition metal—sulfur dioxide complexes. Ryan, R.R.; Eller, P.G. (Los Alamos Scientific Lab., NM). *Inorg. Chem.;* 15: No. 2, 494-496(1976).

A general molecular orbital model has been proposed which accounts for the geometry of the M-NO (M = transition metal) moiety (linear or bent) in terms of the number of d electrons in the system and the transition metal coordination polyhedron. The results of some extended Huckel molecular orbital calculations on LnM-A complexes (L = Cl or CO and A = NO or SO_2) which have been performed with a version of this model are reported. Some modifications have been introduced to allow a direct comparison of the geometry and bonding between the NO and SO_2 complexes. (BLM)

54902 Rate constants for unimolecular decomposition at threshold. Klots, C.E. (Oak Ridge National Lab., TN). *Chem. Phys. Lett.;* 38: No. 1, 61-64(15 Feb 1976).

The character of rate constants for a dissociation occurring near threshold on an attractive potential-energy surface is discussed. Application is made to the attachment of electrons to SF_6 and CCl_4, and to the autoionization of SF^-_6. Implications for isotope separation schemes based on the competition between the autoionization and dissociation SF^-_6 are noted.

54903 Non-crystallinity and polymorphism in elemental solids. Wang, R.; Merz, M.D. (Pacific Northwest Labs., Richland, WA). *Nature (London);* 260: No. 5546, 35-36(4 Mar 1976).

A universal correlation of the noncrystalline state with polymorphism is shown on a plot of the number of polymorphic forms vs. the group number for all solid elements in the Periodic Table. Noncrystallinity is favored in elements with a large number of polymorphic forms and a high degree of bonding anisotropy. Five regions were defined with differing conditions for noncrystallinity. It is postulated that the structure of a noncrystalline solid is composed of a finite number of bonding states with the same bond length, angle, and energy as the polymorph. (DLC)

54904 Rydberg, ionic, and valence interactions in the excited states of F_2. Hay, P.J.; Cartwright, D.C. (Los Alamos Scientific Lab., NM). *Chem. Phys. Lett.;* 41: No. 1, 80-83(1 Jul 1976).

The excited states of F_2 have been investigated as a function of the internuclear distance by a series of configuration interaction calculations. Numerous avoided curve-crossings between valence,

Rydberg (3s and 3p), and ionic (F^+F^-) electronic states have been found. Trnsition moments from the ground state to the lowest dipole allowed Rydberg states are presented.

54905 Collisional mixing of the lowest bound molecular states in xenon and argon. Keto, J.W. (Rice Univ., Houston, TX); Gleason, R.E. Jr.; Bonifield, T.D.; Walters, G.K.; Soley, F.K. *Chem. Phys. Lett.;* **42**: No. 1, 125-128(15 Aug 1976).

Rates are reported for transitions induced between the lowest excited 1/sub u/ and 0^+/sub u/ states of Xe_2 by collisions with electrons and ground-state xenon atoms. Upper limits are established for the corresponding rates in argon, in the case of molecule—atom collisions.

54906 Towards an explanation of collisionless multiple-photon laser dissociation of SF_6. Cantrell, C.D.; Galbraith, H.W. (Los Alamos Scientific Lab., NM). *Opt. Commun.;* **18**: No. 4, 513-516(Sep 1976).

The rapidity and high degree of molecular vibrational excitation by the absorption of ir laser light in SF_6 and other molecules may be due in large part to the anharmonic splitting of excited vibrational states. Anharmonic splitting of an overtone or combination vibrational level (i) is possible only in molecules with degenerate vibrational states, (ii) can be comparable in magnitude to the net anharmonic shift of the level, (iii) is generally much larger than the rotational shifts which have previously been proposed as an explanation for the dissociation of SF_6. Consecutive nearly resonant transitions are possible in SF_6 up to $\nu_3 = 5$ to 10.

54907 Acid-base properties of molecules in excited electronic states utilizing ion cyclotron resonance spectroscopy. Freiser, B.S.; Beauchamp, J.L. (California Inst. of Tech., Pasadena). *J. Am. Chem. Soc.;* **99**: No. 10, 3214-3225(11 May 1977).

A general method is described for obtaining excited state acid-base properties of molecules and ions in the gas phase which utilizes ion cyclotron resonance spectroscopy for studying photochemical processes involving ions. These processes, including photodissociation and photodetachment, yield in favorable instances electronic excitation energies of ions. A comparison of the excitation energies of a base B with the corresponding acid-base complex AB yields the excited state basicity of B. Similarly, a comparison of the excitation energies of a chromophoric acid A with the complex AB yields information about the excited state acidity of A. Studies of the first type are described using the reference acids H^+ and Li^+ with the bases C_6H_5X (X = H, CN, NH_2, CHO, $COCH_3$, NO_2, OCH_3, O^-, and S^-), pyridine, and ferrocene. In several instances photodissociation spectra of solvated acid-base complexes of the type B_3Li^+ have been obtained and analyzed to determine the effects of further solvation on the excitation spectra of these complexes. A comparison of the gas-phase excitation spectra of a number of ions to their solution absorption spectra is made. Studies of the second type (excited state acidities) are described using the reference base H^- with the acids $C_6H_5CO^+$ and $C_6H_5CHOH^+$. Calculated changes in acidity and basicity are used to infer changes in electron distributions and dipole moments for excited states, and yield insight into the types of transitions involved. In particular these studies are used to assess the controversial role played by intramolecular charge transfer in the lowest two singlet π yields π^* transitions of monosubstituted benzenes. These results are compared with findings from related experiments and calculations when available.

54908 Nonastannide(4-) anion Sn_9^{4-}, a novel capped antiprismatic configuration (C_4v). Corbett, J.D.; Edwards, P.A. (Iowa State Univ., Ames). *J. Am. Chem. Soc.;* **99**: No. 10, 3313-3317(11 May 1977).

Reaction of alloy compositions near NaSn/sub 2.25/ with 2,2,2-crypt (4,7,13,16,21,24-hexaoxa-1,10-diazobicyclo[8.8.8]-hexacosane) in ethylenediamine yields dark red to black rods which have been shown to be (crypt-Na^+)$_4Sn_9^{4-}$ by x-ray crystallography. The compound crystallizes in the P1 space group with Z = 2 and a = 16.655 (3) A, b = 21.207 (10) A, c = 15.370 (7) A, α = 107.98 (5)°, β = 103.43 (6)°, and γ = 81.70 (9)° at 5°C. The 117 independent (nonhydrogen) atoms in the structure yielded, with anisotropic thermal parameters for tin and sodium, R = 0.121 and R/sub w/ = 0.143 for 4803 independent observed reflections with $0 < 2\theta < 45°$. One of the four cations exhibits the first example of six rather than eight coordination by 2,2,2-crypt with two opposite oxygen atoms displaced from the coordination sphere (3.12 and 3.30 A from sodium). The novel anion Sn_9^{4-} represents the first example of a unicapped antiprismatic (C/sub 4v/) configuration, the distinguishing dihedral angles being: square base (vicinal), delta = 2.6 (2)°, opposed (parallel to fourfold, delta = 157.7 (1)°, 158.3 (1)°. The contrast between the C/sub 4v/ symmetry of Sn_9^{4-} and the D/sub 3h/ symmetry known for the isoelectronic Bi_9^{5+} (in the $HfCl_6^{2-}$ salt) is considered in terms of a potential stereochemical nonrigidity. The distorted Bi_9^{5+} found in the "monochloride" salt $Bi_{12}Cl_{14}$ exhibits dihedral angles which indicate a 25% distortion from D/sub 3h/ toward C/sub 4v/ symmetry. Semiempirical SCF-CNDO-MO calculations suggest there is a negligible barrier along the geometric path between these two limits.

54909 Synthesis and characterization of bis(fulvalene)dimolybdenum and its monocarbonyl. Smart, J.C.; Curtis, C.J. (Univ. of California, Berkeley). *J. Am. Chem. Soc.;* **99**: No. 10, 3518(11 May 1977).

The synthesis of bis(fulvalene)dimolybdenum (1) and its monocarbonyl adduct, bis(fulvalene)dimolybdenum monocarbonyl (2) is reported. The synthesis of 1 utilized an in situ preparation of the bicyclopentadienide or fulvalene dianion, followed by reaction with molybdenum(II) acetate to yield the dinuclear complex as a slightly soluble, dark red, air-sensitive solid.

54910 Proton spin relaxation and mobility in hydrous melts. Braunstein, J.; Bacarella, A.L.; Benjamin, B.M.; Brown, L.L.; Girard, C.A. (Oak Ridge National Lab., TN). *J. Electrochem. Soc.;* **124**: No. 6, 844-849(Jun 1977).

Pulse and continuous wave NMR measurements are reported for protons in hydrous melts of calcium nitrate at temperatures between -4° and 120°C. At temperatures near 50°C mean Arrhenius coefficients, ΔH/sub $T/_1$ (kcal/mole), are 7.9, 7.3, and 4.8, respectively, for melts containing 2.8, 4.0, and 8.0 moles of water per mole of calcium nitrate, compared to 4.6 kcal/mole for pure water. Temperature dependence of T_1 and T_2 in $Ca(NO_3)_2$-2.8 H_2O between -4° and 120°C are non-Arrhenius and can be represented by a Fulcher-type equation with a "zero mobility temperature" (T_0) of 225°K, close to the value of T_0 for solute diffusion, electrical conductance, and viscosity. Resolution of the relaxation rates into correlation times for intramolecular (rotational) and intermolecular (translational) diffusional motion is discussed in terms of the Bloembergen-Purcell-Pound and more recent models for dipolar relaxation.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

54911 Isotope separation by photochromatography. Suslick, K.S. (to Energy Research and Development Administration). US Patent 4,010,100. 1 Mar 1977. Filed date 3 Oct 1975. 8p.

PAT-APPL-619,156.

An isotope separation method is claimed which comprises physically absorbing an isotopically mixed molecular species on an adsorptive surface and irradiating the adsorbed molecules with radiation of a predetermined wavelength which will selectively excite a desired isotopic species. Sufficient energy is transferred to the excited molecules to desorb them from the surface and thereby separate them from the unexcited undesired isotopic species. The method is particularly applicable to the separation of hydrogen isotopes.

54912 Hydrogen—deuterium exchange in acetylene and between acetylene and water. Pyper, J.W.; Liu, D.K.K. (Department of Chemistry, Lawrence Livermore Laboratory, Livermore, California 94550). *J. Chem. Phys.;* **67**: No. 2, 845-846(15 Jul 1977).

Calculations of equilibrium constants for reactions $C_2H_2 + C_2D_2 = 2C_2HD$ and $C_2H_2 + D_2O = CD_2 + H_2O$ are reported. These calculations were performed in the harmonic approximation. (AIP)

ORGANIC CHEMISTRY

54913 Population balance approach to modelling of continuous emulsion polymerization. Thompson, R.W.; Stevens, J.D. (Iowa State Univ., Ames). *Chem. Eng. Sci.;* **32**: No. 3, 311-322(1977).

A population balance approach is used to mathematically model continuous emulsion polymerization. The Smith-Ewart recursion relation is incorporated directly as the "rate of formation" relation for polymer particles. As a result of this approach, the mechanism of free radical desorption from polymer particles is easily included, and finite termination rates in particles are allowed. Particle growth is incorporated in the model, and particle size distributions are easily obtained. A brief parameter study is conducted. Model predictions are compared to data from the literature. Practical consequences of changes in system parameters are discussed.

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 53607, 53659, 53681, 53683, 53690, 53691, 53692, 53898, 54755, 54889, 54895, 54896, 54907, 54908, 54909, 54937

54914 (AD-A—038086) The effect of lanthanide shift reagents on the proton NMR spectra of vinyl polymers. Final report Jun 74-Feb 76. Arrington, K.; Taylor, R.C. (Oakland Univ., Rochester, Mich. (USA). Dept. of Chemistry). 11 Mar 1977. Contract N00014-75-C-1004. 25p. NTIS, PC A02/MF A01.

An attempt was made to characterize the stereoregularity of vinyl polymers using paramagnetic lanthanide shift reagents in conjunction with a 60 MHz nmr spectrometer. Eu(fod)3 and Eu(fod)3-d27 were the reagents of choice based on a combination of line

broadening effects and the magnitude of the induced chemical shift of the t-butyl protons in poly (t-butyl-methacrylate). Isotactic and atactic samples of poly(methylmethacrylate) were investigated, but the use of the aforementioned shift reagents did not significantly improve the spectral resolution of triad sequences in these polymers. It was concluded that lanthanide shift reagents, when used in conjunction with a 60 MHz instrument, do not yield any additional information about microstructures of vinyl polymers. (Author)

54915 (BDX—613-1480(Rev.)) **Synthesis of polyaminobismaleimide.** Jamieson, D.R. (Bendix Corp., Kansas City, Mo. (USA)). Nov 1975. Contract EY-76-C-04-0613. 27p. Dep. NTIS, PC A04/MF A01.

Studies were conducted on a laboratory scale to determine chemical routes required to reproduce the commercial resin system, Kerimid 601. The resin was identified as polyaminobismaleimide. Reaction variables, pertinent to the synthesis of the resin precursor, were studied and formulations resembling the commercial resin were prepared for evaluation. Results indicate technical feasibility for producing this resin.

54916 (ANL-Trans—1089) **Proton-spin relaxation of benzene on silica gel surfaces.** Michel, D. Translated from *Z. Naturforsch., a;* **23**: 339-347(1968). 17p. Dep. NTIS, PC A02/MF A01.

Using spin-echo-techniques the temperature dependence of the proton magnetic relaxation times T_1 and T_2 of adsorbed benzene has been measured in the interval between +70°C and -140°C. Normal benzene C_6H_6 and mixtures of benzene and C_6D_6 were adsorbed on two sorts of silica gels which have been described elsewhere. The effective nuclear magnetic relaxation rates of adsorbed benzene are given by four contributions: the intramolecular proton-proton interaction, the interaction between benzene protons and paramagentic impurities of the adsorbents, the interaction between benzene protons and hydroxyl protons on the silica gel surface, and the intermolecular interaction between benzene protons. These proton relaxation mechanisms depend differently on the II/D-ratio in C_6H_6—C_6D_6 mixtures. The temperature dependence of the contributions $1/T_1$ intra and $1/T_2$ intra due to intramolecular proton-proton interaction suggests an anisotropic rotation of benzene molecules on the gel used. Furthermore, the existence of three different regions for the adsorbed benzene molecules has been inferred.

54917 Propellanes. VII. Bridgehead olefins via acetolysis. Warner, P.; Lu, S.L.; Myers, E.; DeHaven, P.W.; Jacobson, R.A. (Ames Lab., Iowa). *Tetrahedron Lett.;* No. 50, 4449-4452(1975).

Some of the chemistry involved in the Ag^+-assisted solvolysis of tricyclic cyclopropyl halides has recently been elucidated. Evidence has accumulated for the protic capture of bridgehead olefin intermediates. In the course of a kinetic study, it became necessary to determine the reaction mode under non-assisted conditions. Product studies which also implicate bridgehead olefins are reported.

54918 Determination of the percentage content of chlorine bound in chlorkerosene with the aid of inductive transducers. Mamedov, F.I.; Dadasheva, R.B.; Miralaev, T. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 9, 92-94(1976). (In Russian).

A method of quality control of detergents produced on the basis of chlorkerosene is considered. It is shown that there is a linear dependence between the content of bound chlorine and specific weight of chlorkerosene. This permits realization of detergents quality control by specific weight changes. It is proposed to utilize a differential-transformer transducer with an elastic sensitive element for this purpose. The quality of the detergent can be evaluated by the output voltage of the differential-transformer transducer.

54919 Enthalpies of formation of five isomeric heptenes. Good, W.D. (Bartlesville Energy Research Center, OK). *J. Chem. Thermodyn.;* **8**: 67-71(1976).

The enthalpies of combustion of five isomeric heptenes were measured by precision oxygen-bomb combustion calorimetry. The following values are reported for the standard enthalpy of combustion, $\Delta H°(298.15K)$/kcal/sub th/mol^{-1}, of these compounds in the liquid state: 1-heptene, -(1113.05 +-0.18); cis-2-heptene, -(1111.43 +-0.19); trans-2-heptene, -(1110.38 +- 0.18); cis-3-heptene, -(1111.63 +-0.16); and trans-3-heptene, -(1110.43 +- 0.22). Values of enthalpy of formation in the liquid state were derived. The value obtained for 1-heptene, the only compound studied previously by modern calorimetry, is in good agreement with that of an earlier combustion calorimetric study and in excellent agreement with that of an earlier enthalpy-of-hydrogenation study.

54920 Kinetics of the disordered chain-to-β transformation of poly(L-tyrosine) in aqueous solution. Auer, H.E.; Patton, E. (Univ. of Rochester, NY). *Biophys. Chem.;* **4**: 15-21(1976).

The kinetics of the transformation of poly(L-tyrosine) from the disordered chain to the intramolecular β structure in aqueous solution has been studied. The reaction is induced by an isothermal pH jump and is followed by conventional circular dichroism methods. Upon application of curve-fitting procedures, it is found that the kinetics are poorly represented by a single first-order process, but a two-step sequential first-order equation is adequate. Sharp pH-dependent maxima in the phenomenological rate constants and in the fractional amplitude of the rapid step were found. It is proposed to attribute these phenomena to a transition in initial states which is shown to occur over the same pH range within the domain of the disordered-to-β transition. No sigmoid transient curves were observed, indicating that no slow nucleation events are discernible in this system. These observations contrast strikingly with the mechanism elaborated for β formation in (Lys)/sub n/[R. Hartman et al., J. Mol. Biol., 90 (1974)415].

54921 Preparation and properties of the repeating sequence polymers d(A-I-C)/sub n/.d(I-C-T)/sub n/ and d(A-G-C)/sub n/.d(G-C-T)/sub n/. Ratliff, R.L.; Hoard, D.E.; Hayes, F.N.; Smith, D.A.; Gray, D.M. (Los Alamos Scientific Lab., NM). *Biochemistry;* **15**: No. 1, 168-176(1976).

The repeating sequence polymer d(A-I-C)/sub n/ x d(I-C-T)/sub n/ has been prepared using the chemically synthesized oligomers $d(A\text{-}G\text{-}C)_4$ and $d(C\text{-}T\text{-}G)_4$ and the DNA polymerase from Micrococcus luteus. The enzymatically synthesized polymer was used as a template for preparation of d(A-G-C)/sub n/ x d(G-C-T)/sub n/. Both deoxyribonucleotide polymers were characterized by nearest neighbor analyses, buoyant density measurements in cesium chloride and cesium sulfate, melting temperature, and circular dichorism (CD) spectra. The ribopolymers r(A-I-C)/sub n/ x r(I-C-U)/sub n/ and r(A-G-C)/sub n/ x r(G-C-U)/sub n/ were transcribed from d(A-I-C)/sub n/ x d(I-C-T)/sub n/, and their CD spectra were compared with those of the respective deoxyribonucleotide polymers.

54922 Motion of thermal electrons in n-alkane vapors. Christophorou, L.G.; Grant, M.W.; Pittman, D. (Oak Ridge National Lab., TN). *Chem. Phys. Lett.;* **38**: No. 1, 100-105(15 Feb 1976).

The mobilities of thermal electrons in n-alkane vapors decrease with increasing static polarizability and the measured scattering cross sections compare well with the geometric cross sections. Evidence is provided for the existence of a Ramsauer—Townsend minimum in C_2H_6 and C_3H_8.

54923 Electrochemical synthesis and structural characterization of the iron—sulfur cluster cation $[(eta\text{-}C_5H_5)_2Fe_2(S_2)(SC_2H_5)_2]^+$. Vergamini, P.J.; Ryan, R.R.; Kubas, G.J. (Los Alamos Scientific Lab., NM). *J. Am. Chem. Soc.;* **98**: No. 7, 1980-1982(31 Mar 1976).

Structural characterization of both components of an electrochemically reversible couple in $[(N\text{-}C_5H_5)_2Fe_2(S_2)(SC_2H_5)_2]^+$ was used to derive an electron-pair coupling mechanism which is consistent with the observed structural and magnetic properties. (DLC)

54924 Theory of pure rotational Raman transitions in the vibronic ground state of a tetrahedral molecule. Rosenberg, A.; Chen, K.M. (Ames Lab., IA). *J. Chem. Phys.;* **64**: No. 12, 5304-5305(15 Jun 1976).

It is well known that the polarizability tensor of a rigid tetrahedral rotor is isotropic. Hence, pure rotational Raman transitions in the vibronic ground state of a tetrahedral molecule are forbidden. However, the distortion of the molecule by centrifugal forces produces an effective anisotropic polarizability tensor, which depends on the components of the total angular momentum, and results in a pure rotational Raman spectrum. The purpose of this communication is to give explicit expressions for the polarizability tensor operator and the scattering intensity of the pure rotational Raman transitions. The feasibility of observing such transitions and an estimate of the relative intensity are given for the case of methane. The results presented here have been derived partially by considering the matrix elements of the linear normal coordinate terms in the polarizability tensor, between perturbed wavefunctions that were obtained by mixing the ground state with the degenerate excited vibrational states. The existence of similar "forbidden" pure rotational transitions in the far infrared region were established recently both on theoretical and experimental grounds.

54925 Study of satellite structure found in the photoelectron spectra of gaseous alkenes. Carlson, T.A.; Dress, W.B.; Grimm, F.A.; Haggerty, J.S. (Oak Ridge National Lab., TN). *J. Electron Spectrosc. Relat. Phenom.;* **10**: 147-154(1977).

The satellite structure in the photoelectron spectrum of the C(1s) shell has been studied for the following compounds: ethylene, propylene, 1-butene, trans-2-butene, cis-2-butene, butadiene and, for comparison, propane. The structure can be divided into two parts: a relatively sharp peak due to π yields π^* excitation and a broad complex band involving excitation of sigma orbitals. Calculation of electron shakeup probabilities has been carried out using CNDO wave functions and compared with experiment. Reasonably good agreement was obtained, and the general problem of characterizing carbon-carbon double bond behavior by satellite structure due to electron shakeup is discussed.

54926 Process for the preparation of aminated polymers useful as additives for fuels and lubricants. Song, W.R.; Gardiner, J.B.; Engel, L.J. (to Exxon Research and Engineering Co.). US Patent 4,032,700. 28 Jun 1977. Filed date 15 Sep 1975. 16p.

This patent pertains to the preparation of animated polymeric additives useful as oil additives, for example as dispersants for hydrocarbon fuels and lubricants, and as multifunctional dispersant-viscosity index improvers for lubricants. Amine is reacted with a halogen containing copolymer of ethylene, a C_3 to C_{18} straight or branched chain α-olefin and a C_5 to C_{14} acyclic or alicyclic nonconjugated diolefin, said halogen containing copolymer being prepared by the halogenation of said copolymer.

54927 Determination of the epoxide equivalent weight of glycidyl ethers by proton magnetic resonance spectrometry. Dorsey, J.G.; Dorsey, G.F.; Rutenberg, A.C.; Green, L.A. (Oak Ridge Y-12 Plant, TN). *Anal. Chem.;* **49**: No. 8, 1144-1145(Jul 1977).

A proton nuclear magnetic resonance method to determine the epoxide equivalent weight (EEW) of several commercial epoxy resins has been developed. The precision and accuracy of the proton NMR method have been calculated for commercial resins as well as phenyl glycidyl ether. The data compare well with that of the conventional ASTM method of reacting the epoxy with hydrogen bromide in glacial acetic acid. The EEW of phenyl glycidyl ether at the 95% confidence interval determined by the proton NMR method is 150.2 +- 1.1 and by the ASTM method is 151.6 +- 0.6 as compared to a theoretical value of 150.17. The proton NMR method is rapid, free of interfering chemical reactions, requires a small sample, and simultaneously provides a fingerprint of the material investigated.

ELECTROCHEMISTRY

54928 Interferometric study of transient diffusion layers. McLarnon, F.R.; Muller, R.H.; Tobias, C.W. (Univ. of California, Berkeley). *Electrochim. Acta;* **21**: 101-105(1976).

Transient refractive-index fields in stagnant $CuSO_4$ solutions were measured by double beam interferometry during the galvanostatic deposition of copper. Concentration profiles in the electrolyte were derived from the interferograms by correcting for optical aberrations caused by beam deflection and reflection. The time-dependent concentration profiles are in good agreement with those derived from a solution of the diffusion equation in which the concentration dependence of diffusivity is taken into account.

PHOTOCHEMISTRY

54929 (PB—265592) Mechanisms of photochemical reactions in urban air. Volume I. Chemistry studies. Final report 1 Dec 71-1 Dec 74. Pitts, J.N. Jr. (California Univ., Riverside (USA). Statewide Air Pollution Research Center). Feb 1977. 184p. NTIS, PC A09/MF A01.

See also Volume 2, PB-265 593.

Results are presented of a research program concerned with selected aspects of the kinetics, mechanisms and products of reactions involved in photochemical air pollution. Rate constants were determined, using competitive and modulation-phase shift techniques, for the gas phase reaction of O(triplet P) atoms with a variety of organic and inorganic species over the temperature range 296-423K. Products for the gas phase reaction of O(triplet P) atoms with toluene and 1-methylcyclohexene were also studied. The products and mechanisms of the reaction of nitric oxide with methyl peroxy radicals were investigated at 296K using long path infrared spectroscopic and gas chromatographic techniques. The reactions of peroxyacetyl nitrate were investigated in the gas phase with selected constituents of polluted atmospheres, and in the liquid phase with a variety of organics. Chemiluminescence from the reaction of peroxyacetyl nitrate with a series of amines was studied in the liquid phase. The mechanism and products of the gas phase reactions of ozone with a variety of organics was investigated in low pressure flow systems using chemiluminescent and photoionization mass spectrometric techniques. The NO_2-catalyzed geometric isomerization of 2-butenes and 2-pentenes was studied over the temperature range 298-400K while an investigation of the NOx-propylene photooxidation system was carried out at room temperature.

54930 (PB—265593) Mechanisms of photochemical reactions in urban air. Volume II. Chamber studies. Final report 1 Dec 71-1 Dec 74. Pitts, J.N. Jr; Darnall, K.R.; Winer, A.M.; McAfee, J.M. (California Univ., Riverside (USA). Statewide Air Pollution Research Center). Feb 1977. 255p. NTIS, PC A12/MF A01.

See also Volume 1, PB-265 592.

The smog chamber facility of the Statewide Air Pollution Research Center has been employed in a study designed to provide experimental data required for the validation of kinetic computer models of chemical transformations in polluted atmospheres. A 5800-l, Teflon-coated, evacuable chamber and 25-KW xenon arc solar simulator were used for irradiations, under simulated atmospheric conditions, of hydrocarbon-NOx systems. Detailed time-concentration profiles were obtained for a wide range of products as well as the reactants employed. Relative and absolute concentrations of the hydrocarbon-NOx systems were chosen on a factorial design basis. This report presents results obtained in the first eighteen months of the program (July, 1973 through November, 1974). Preliminary chamber and light source characterization studies were carried out and included determination of ozone lifetimes, absolute light intensity, spatial homogeneity of light within the chamber, mixing and equilibration times, and sampling rates. Some preliminary efforts to characterize surface effects were also made. The photochemistry program included investigation of the propylene-NOx and n-butane-NOx photo-oxidation systems and also a study of the effects on these systems of variables such as added aldehydes, temperature, and initial NO/NO_2 ratio. Data from this experimental program are presented, and their uses and limitations discussed.

54931 (LA-tr—77-45) Study of photodissociation of PH_3 in the quartz uv by absorption spectroscopy flash photolysis. Kley, D.; Welge, K.H. Translated from *Z. Naturforsch., a;* **20**: 124-131(1965). 21p. Dep. NTIS, PC A02/MF A01.

Photodissociation of PH_3 in the quartz UV was studied by absorption spectrography detection of the PH and PH_2 radicals using a fast flash photolysis setup. Above 1950 A, the PH_3 molecule possesses the following two possibilities for dissociation: $PH_3 + hv$ yields $PH_2^* + H$ and $PH_3 + hv$ yields $PH^* + H_2$. The absorption intensities of the radical spectra increase sharply with the pressure of foreign gases (H_2, N_2, Ar, CO_2) within the first microseconds after the photolysis flash at low PH_3 pressures (several tenths of a torr); the increase is a function of the type of added gases in the case of the PH spectrum. These relationships are explained as follows: the majority of PH and PH_2 radicals (more than 90 percent and 60 percent, resp.) undergo primary formation with vibrational excitation in the electronic ground states, or in excited metastable electronic states. Deactivation of the PH_2^* radicals by the foreign gases requires on the order of 10^5 collisions, whereas considerably more collisions are necessary to deactivate the PH^* radicals. Without added gases, the excited radicals react before they reach the ground states. In another part of the work, the absorptivity of PH_3 above 1950 A was measured and the PH_3 absorption spectrum studied.

54932 Laser photodissociation of benzene radical cations. Evidence for a two photon process involving a long lived intermediate. Freiser, B.S.; Beauchamp, J.L. (California Inst. of Tech., Pasadena). *Chem. Phys. Lett.;* **35**: No. 1, 35-40(15 Aug 1975).

A novel two photon process is reported in which benzene radical cation, $C_6H^+{}_6$, photodissociates upon irradiation from an intense argon ion laser to produce predominantly $C_6H^+{}_5$ and H at photon energies significantly below thermodynamic threshold. The partial photoexcitation spectrum for this process, as well as the photoexcitation spectrum for the direct single photon process occurring at higher energies, is compared to the photoelectron spectrum of benzene and to calculations on the spectrum of benzene radical cation to elucidate the nature of the transitions involved.

54933 Mobile charge carriers in photosynthesis. Bogomolni, R.A.; Klein, M.P. (Lawrence Berkeley Lab., CA). *Nature (London);* **258**: No. 5530, 88-89(6 Nov 1975).

The presence and trapping of charge carriers of both signs in photosynthesis are confirmed by measurements of light-induced changes in the real and imaginary parts of the complex dielectric constant at 9 GHz in films of chloroplasts and chromatophores from photosynthetic bacteria. Results can be understood in terms of photoliberated charges migrating for short distances through a dielectric medium. The microwave Hall mobilities are similar to those expected for tunneling or hopping processes. The number of traps and the max number of free carriers approximate the number of reaction centers. (DLC)

54934 Quenching rate constants for the removal of $SO_2(^3B_1)$ by various fluorinated olefins. Wampler, F.B. (Los Alamos Scientific Lab., NM). *Int. J. Chem. Kinet.;* **8**: 687-694(1976).

From 172. ACS national meeting; San Francisco, CA, USA (29 Aug 1976).

A competitive technique employing the $SO_2(^3B_1)$ photosensitized isomerization of cis-C_2FH_2 to trans-$C_2F_2H_2$ in the presence of selected fluorinated olefins has been used at 3712 A and 22°C to determine the quenching rate constants of the reaction $SO_2(^3B_1) + M$ yields removal. With P/sub SO_2/ = 25.4 torr and P/sub cis-$C_2F_2H_2$/ = 0.239 torr Stern—Volmer plots for M = C_6H_6, C_6H_5F, 1,1-$C_2F_2H_2$, C_6F_6, and C_6F_6 yielded k_4 (units of 10^{10} l./mole.sec) values of 5.29 +- 0.16, 4.21 +- 0.53, 1.92 +- 0.23, 0.575 +- 0.060, and 0.0335 +- 0.0027, respectively. The results were consistent with the ability of an olefin to quench $SO_2(^3B_1)$ being inversely proportional to the polarizability of the olefin's π bond and the effect can

be clearly noted as each H atom in C_2H_4 is individually replaced by an F atom.

54935 Stimulated Raman emission at 9.2μm from hydrogen gas. Loree, T.R.; Cantrell, C.D.; Barker, D.L. (Los Alamos Scientific Lab., NM). *Opt. Commun.;* **17**: No. 2, 160-162(May 1976).

Light at 1.06 μm from a mode-locked Nd:YAG laser has been successfully down-converted by two vibrational stimulated Raman shifts in H_2 gas. Approximately 1 MW of power was produced at the second-Stokes wavelength, 9.20 μm. Many other rotational and vibrational shifts were observed, up to the seventh anti-Stokes at 260 nm.

RADIATION CHEMISTRY

54936 Kinetic and product distribution analysis for competitive recombination reactions. Ehrenson, S. (Brookhaven National Lab., Upton, NY). *Int. J. Chem. Kinet.;* **7**: 829-836(1975).

Exact solution methods are developed for the complex kinetic and product distribution equations encountered in a particular type of competitive recombination or crossover reaction involving "cages." Pertinent reaction systems are those where scavenging of the intermediates escaping the cages is restricted to species similar to these intermediates, thereby limiting potentially undesired side effects of the scavenger. The trustworthiness of the reaction constants which may be obtained, particularly the fraction of recombination occurring within the cage, are analyzed in terms of sources of possible error. Several extensions of the method are briefly discussed, such as in distinctions between inter- and intramolecular rearrangement. Full detailing of the solution methods should facilitate their use in the analysis of similar reaction schemes.

54937 Kinetics of geminate-ion recombination by electron tunnelling. Tachiya, M.; Mozumder, A. (Univ. of Notre Dame, IN). *Chem. Phys. Lett.;* **34**: No. 1, 77-79(1 Jul 1975).

A phenomenological model is developed for geminate-ion recombination by electron tunnelling. Experimentally observed decay kinetics of recombination luminescence is well described by this model.

54938 Gas release from surfaces under x ray impact: photodesorption, photocatalysis. Brumbach, S.; Kaminsky, M. (Argonne National Lab., IL). *Adv. Chem. Ser.;* No. 158, 5-10(1976).

Experimental data on x-ray-induced gas adsorption and gas release from surfaces are reviewed with results for stainless steel and Al_2O_3 surfaces. CO_2 and O_2 are the major species which desorb from such surfaces under x-ray irradiation. Mean quantum yields are given for these systems. Results from experiments using photons of lower (e.g., visible or uv range, synchrotron radiation) or higher (γ-ray) energy help to interpret the data obtained with photons in the x-ray range. X-ray-induced photodesorption needs to be considered in attaining high vacuum in plasma containment devices.

54939 Theoretical studies of excited states of H_2O and of core-excited NH_3: comparisons with equivalent core analysis of NH_3 core-excitation spectra and implications for the radiation chemistry of aqueous systems. Schwartz, M.E. (Univ. of Notre Dame, IN). *Chem. Phys. Lett.;* **40**: No. 1, vp(15 May 1976).

The H_2O radical has been studied within the ab initio LCAO SCF MO model. A flexible basis set including diffuse basis functions at both O and H has been used in order to represent the excited states adequately. Calculated excitation energies are 1.87, 2.87 to 3.16, and 3.36 to 3.47 eV; the calculated ionization energy is 4.75 eV. These represent well the experimental values (good to +-0.3 eV) of 1.6, 2.9, and 3.5 eV for excitation, and 5.0 eV for ionization, deduced by equivalent core analysis of high energy electron impact energy loss studies of NH_3. Similar explicit calculations on the N-1s core-excited states of NH_3 have also been made to examine directly the equivalent core concept. "Excited states" (relative to the lowest bound core-excited state) at 1.72, 2.85 to 3.09, and 3.32 eV, and the "ionization energy" of 4.68 eV, agree well with experiment and support the equivalent core concept. The possible significance of these H_2O results in the radiation chemistry of aqueous media is discussed in view of the fact that the maximum in the absorption spectrum of the hydrated electron lies near that of H_2O.

54940 Differential saturation study of radial and angular modulation mechanisms of electron spin—lattice relaxation for trapped hydrogen atoms in sulfuric acid glasses. Plonka, A.; Kevan, L. (Wayne State Univ., Detroit). *Chem. Phys. Lett.;* **43**: No. 3, 489-492(1 Nov 1976).

A differential ESR saturation study of allowed transitions and forbidden proton spin-flip satellite transitions for trapped hydrogen atoms in sulfuric acid glasses indicates that angular modulation dominates the spin-lattice relaxation mechanisms and suggests that the modulation arises from motion of the H atom.

54941 Photoelectron spectroscopy of carbonyls. Biological molecules. Dougherty, D.; McGlynn, S.P. (Coates Chemical Laboratories, The Louisiana State Unversity, Baton Rouge, Louisiana 70803). *J. Chem. Phys.;* **67**: No. 3, 1289-1290(1 Aug 1977).

Photoelectron spectra of cylosine and guanine have been obtained with HeI excitation. The correlation between electronic structure and biological function of these biologically significant molecules is discussed in detail. (AIP)

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

REFER ALSO TO CITATION(S) 54548

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 54012

54942 (AD-A—038750) **Reaction rate data. Number 58. Annual summary of progress in FY 1976 and 7T DNA reaction rate program.** (General Electric Co., Santa Barbara, Calif. (USA)). Nov 1976. Contract DNA001-75-C-0023. 28p. NTIS PCA03/MF A01.

Our DCHEM coupled reaction rate code has been updated to include the latest data concerning chemical reactions and rate constants. Particular attention was given to the neutral chemistry involving hydrogen and TO ion hydration reactions and TO ion-ion and electron-ion recombination rate constants. In addition, the code has been revised and will now provide values of the 'effective rate constant' at any time desired. This will facilitate use of the code results in modeling efforts and in sensitivity calculations.

54943 Radiopharmaceuticals. 16. Halogenated dopamine analogs. Synthesis and radiolabeling of 6-iododopamine and tissue distribution studies in animals. Fowler, J.S. (Brookhaven National Lab., Upton, NY); MacGregor, R.R.; Wolf, A.P.; Ansari, A.N.; Atkins, H.L. *J. Med. Chem.;* **19**: No. 3, 356-360(1976).

A simple halogenated derivative of dopamine, 6-iododopamine (1), has been synthesized using two different methods. These synthetic sequences have been applied to the radiolabeling of 1 with carbon-11, iodine-131, and iodine-123. The tissue distribution of 1 in mice, dogs, and rats was determined. The ratio of radioactivity (percent/g) in the adrenal medulla-kidney in dogs increases from 3.45 at 2 h postinjection to 33.3 at 24 h postinjection. Thyroid uptakes in mice, dogs, and rats show that in vivo deiodination of 1 is not significant.

COMBUSTION CHEMISTRY

REFER ALSO TO CITATION(S) 53683

54944 (AD-A—037976) **Gasification and ignition of a condensed fuel by a hot stagnant gas. Final report Apr 73-Apr 76.** Kindelan, M.; Linan, A. (Instituto Nacional de Tecnica Aerospacial, Madrid (Spain)). 1977. Contract F61052-69-C-0036. 15p. NTIS, PC A02/MF A01.

Asymptotic techniques based on the limit of high activation energy have been used to analyze the ignition process of a condensed fuel suddenly exposed to a hot stagnant gas. Several cases are studied differing in the location of the exothermic ignition reaction. In a first part, an analysis is presented of the gasification process when an equilibrium process or a rate process is considered to determine the gasification rate, and the use of these results to study ignition by a fast exothermic gas-phase reaction. In a second part an analysis is presented of ignition by a heterogeneous exothermic reaction including the convective effects of the gasification flow. In a third part an analysis is presented of ignition by a condensed phase reaction and the derivation of a closed form expression for the ignition time. In a fourth part an analysis is presented of the heterogeneous ignition process by convective heating described by a Newtonian law. Details of these analyses are given in previous Scientific Reports. (Author)

54945 (UCRL—52000-77-4, pp 1-12) **Modeling combustion processes.** Routh, J. Apr 1977.

In Energy and technology review.

Computer codes are being developed to provide detailed numerical descriptions of combustion processes for design of burners, furnaces, and internal combustion engines. The computer model of the methane combustion reaction, including 20 chemical species and 54 reactions, agrees well with experimental results. A one-dimensional computer model of the combustion of a stratified charge in an automobile engine indicates that this concept should reduce hydrocarbon emissions. A very fast two-dimensional hydrodynamic code was completed that has calculated air flow patterns in

the idealized engine. We are working to add fuel-spray simulation and simplified chemical kinetics to it. Layout of a three-dimensional combustion code was begun. To test the accuracy of the calculations, a number of combustion and spray-injection experiments were also devised.

54946 Use of laser Raman diagnostics in flow fields and combustion. Lederman, S. (Polytechnic Inst. of New York, Farmingdale). *Prog. Energy Combust. Sci.;* 3: No. 1, 1-34(1977).

After a short review of radiation and infrared spectroscopy based on Herzeberg, and Mansel and Davis, the theory of Raman scattering and its relation to infrared spectroscopy are discussed. Some remarks concerning other diagnostic methods are made. Flow parameters obtainable and techniques applicable towards their measurement are indicated. The acquisition of the same flow parameters by the use of Raman scattering is presented. The lasers suitable for this purpose, as well as the data acquisition, processing and recording equipment necessary are discussed. Finally, some specific experimental arrangements and results are presented. 44 figures, 51 references. (DLC)

ENGINEERING

GENERAL ENGINEERING

REFER ALSO TO CITATION(S) 55536

FACILITIES AND EQUIPMENT

54947 (K-GD—1161) **Orifice calibration.** Conley, T.B. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). Jan 1975. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A02/MF A01.

In the Aerodynamic Separation Experimental Studies Program, one of the problems that has arisen is the measurement of flow through an orifice at pressures in the range of a few torr. Due to lack of experience in using orifices in this pressure range, measurements were made to verify that there were no anomalies in the theory that the flow is proportional to the square root of the average pressure, P, times the pressure drop, ΔP, across the orifice. Because of other special conditions, the orifices would be used with pressure drops of only a fraction of the absolute pressure. If the orifices were to be used in the critical regime, it would increase pressures on the forepressure side by an unacceptable amount. In this case, the orifice to be calibrated was 0.74 in. in dia. A schematic diagram of the experimental arrangement is shown.

54948 (SAND—77-7005(Vol.1)) **Pressure and profile data of 20° conical ribbon parachutes.** Heinrich, H.G.; Uotila, J.I. (Sandia Labs., Albuquerque, N.Mex. (USA)). May 1977. Contract EY-76-C-04-0789. 136p. Dep. NTIS, PC A07/MF A01.

Wind tunnel data of 3-ft ribbon parachute models concerning canopy profiles, drag forces and pressure distribution are presented. The data were analyzed and resulted in presentations of drag coefficients, projected diameters, and drag areas of reefed and unreefed parachutes versus geometric porosity and suspension line length as well as in tables and graphs of canopy coordinates and related pressure distributions. Pressure integration about the canopy surfaces as given by the established coordinates provided drag forces which agreed satisfactorily with measured forces. Also, radial force coefficients of the various configurations were established. Results are intended as background information for related investigations on parachute dynamics, stress analysis, etc. The data are presented in two volumes, Volume I being a summary report, while Volume II contains the bulk of the data.

54949 (SC-DR—72-779) **Development of a Two-Axis Inertial Attitude Reference Assembly (TIARA).** Wimber, B.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1973. Contract EY-76-C-04-0789. 49p. Dep. NTIS, PC A03/MF A01.

The Two-Axis Inertial Attitude Reference Assembly (TIARA) is the most critical component of a proposed three-axis inertial system. The TIARA uses a Dual Axis Rate Transducer (DART) as the inertial angular rate sensor. Evaluation of the DART is described and TIARA design considerations are discussed. Included are test results which indicate that the TIARA nominal drift rate will be less than 10°/hr if bias adjustment is allowed with no intervening shutdown between adjustment and application.

54950 (Y/EN—123) **Structural modeling using higher-order finite elements.** Beavers, J.E. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1977. Contract W-7405-ENG-26. 19p. (CONF-770816—4). Dep. NTIS, PC A02/MF A01.

From 1. international conference on mathematical modeling; St. Louis, Missouri, United States of America (USA) (29 Aug 1977).

The development and utilization of higher-order finite elements for structural modeling are discussed. The structural type upon which these studies focus is the folded plate concept. The particular higher-order finite elements developed are combined membrane and plate bending elements, and are defined as higher-order in that their displacement fields are basically represented by, or combinations of, cubic and quintic polynomials. The difficulties encountered modeling folded plate structures with higher-order elements are presented. The advantages and disadvantages of the various elements developed are discussed and their superiority over lower-order elements is shown. Examples of folded plate structures are used to exemplify these points, and to show that using higher-order finite elements is a valid and successful tool for modeling linear-elastic response of folded plate structures.

54951 Simulation of gradient and band propagation in the centrifuge. Sartory, W.K.; Halsall, H.B.; Breillatt, J.P. (Oak Ridge National Lab., TN). *Biophys. Chem.;* 5: 107-135(1976).

A technique was developed for simulating the behavior of both the gradient-forming solute and macromolecular bands in a centrifuge. The change with time of the density gradient due to diffusion and sedimentation of the gradient-forming solute is calculated by a finite difference method, making use of the results of earlier work on the theory of the equilibrium density gradient. Using a perturbation technique, the concentration profiles of dilute bands of macromolecules are then calculated as they sediment and diffuse through the varying supporting gradient. Results of the simulation techniques are compared with experiment.

54952 Systematic method for computer design of supercritical airfoils in cascade. Garabedian, P.; Korn, D. *Commun. Pure Appl. Math.;* 29: 369-382(1976).

A computer code has been developed for the direct calculation of shockless transonic airfoils whose pressure distributions can be assigned within reasonable limits. The code is fast and accurate, so that a range of numerical examples can be produced at will. Experience with analysis programs and wind tunnel tests suggests that shockless airfoils designed this way provide a valid first stage in the development of supercritical wing sections. It would be desirable, however, to conduct a more detailed investigation of the effectiveness of the method in suppressing boundary layer separation and drag creep.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 54258, 55007, 55475, 55484, 55485

54953 (AD-A—037970) **Far infrared detection with Josephson junctions. Final report.** So, C.K.; Hamilton, W.O. (Louisiana State Univ., Baton Rouge (USA). Dept. of Physics). Dec 1976. 102p. NTIS, PC A06/MF A01.

Doctoral thesis.

The response of Josephson junctions to microwave and far infrared radiation was studied. Junctions are formed by pressing a Nb or Nb-Ti pointed wire onto a Nb thin film which in turn is pressed against the open end of a waveguide. Electromagnetic radiation is applied through the back of the film so that only the wave magnetic field is coupled to the junctions. The change of the dc Josephson current is monitored at different levels of microwave power over a frequency range from 22GHz to 105GHz. The dependence of the responsivity of these current on film thickness over a range from 50 A to 500 A was studied. The observed responsivity agrees very well with that predicted by theory. Higher responsivity is observed for thinner films and lower microwave frequencies.

PROTECTIVE STRUCTURES AND EQUIPMENT

54954 (CONF-760822—P1, pp 134-170) **Preliminary results of HEPA-filter smoke plugging tests using the LLL full-scale fire test facility.** Gaskill, J.R.; Alvares, N.J.; Beason, D.G.; Ford, H.W. Jr. (Univ. of California, Livermore). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

As reported in previous Air Cleaning Conferences, hot fire gases can impair the integrity of HEPA filters, and smoke particulates can plug them. This pressurizes the room of fire origin and can lead to the spread of radioactive or other toxic contamination. The heat-damaging effect has been overcome using water sprays in the duct. Previous studies on smoke plugging have been inadequate, however, in determining realistic pyrolysis/combustion rates and in evaluating the effects of fuel arrangements, room geometry, and aging of smoke particulates. To overcome these deficiencies, Lawrence Livermore Laboratory has constructed a full-size fire-test

compartment, equipped it with an exhaust-ventilation system, and provided it with a suitable instrumentation- and data-acquisition system. From a survey of ERDA-contractor facilities, a matrix of fuel loadings (kg/m^2 of combustibles) versus dirty-to-clean ratios (relative yield of particulates) has been prepared. From this, a selected series of fuel arrays is being used to determine the life of HEPA filters during test fires. The effects of high- versus low-exhaust takeoff points, as well as the use or nonuse of sprinklers, are also being investigated. The fire test facility is described, and the preliminary results obtained to date are reported.

54955 (CONF-760822—P2, pp 557-563) **Dust filtration on a panel bed of sand.** Goossens, W.R.A.; Francesconi, A.; Dumont, G.; Harnie, R. (CEN, Mol, Belg.). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The development of a panel bed of sand as dust filter is described. The results obtained in a technical set-up with a filtering area of 1 m^2 are given. The data of a 2^4 factorial design experimental campaign are presented in the form of the resulting statistical equation.

54956 (CONF-760822—P2, pp 578-601) **Electrostatic capture of submicron particles in fiber beds.** Reid, D.L.; Browne, L.M. (Pacific Northwest Labs., Richland, WA). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The emission of submicron sized particles is the most difficult to effectively control with current state-of-the-art technology. Experiments at Battelle-Northwest led to the discovery that charged particles could be efficiently captured by a thick fiber bed having a high bed-volume to fiber-volume ratio and a very low pressure drop. Interim results are presented for the removal efficiency as a function of particle resistivity, superficial gas velocity, bed depth and aerosol concentration. In general, for bed pressure drops less than 0.5 in H_2O efficiencies greater than 90 percent were obtained at 300 ft/min (approximately 152 cms/sec) face velocity over the particle size range of 0.06 to 0.7 μm AMD and a particle resistivity range of 10^8 to 10^{12} ohm-cm. The most important variable was the bed face velocity with the collection efficiency varying inversely with velocity. The bed depth and volume void fraction were other significant variables bearing on the efficiency of the system. Empirical equations indicate a 100 percent collection efficiency might be attainable near or somewhat below a bed face velocity of 50 ft/min (approximately 25 cms/sec). However, a more sensitive measurement method would be required for experimental confirmation.

54957 (CONF-760822—P2, pp 602-611) **Air filtration enhancement using electronic techniques.** Nelson, G.O.; Richards, C.P.; Biermann, A.H. Taylor, R.D.; Miller, H.H. (Univ. of California, Livermore). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Dielectrophoretic filtration experiments were conducted on glass, polyester, dacron, Teflon, wool, acrylic and polypropylene filter media. A polydispersed (sigma g = 2.0, ammd = 0.95 μm) sodium chloride particle was used as a test aerosol. All materials exhibited significant increases in efficiency with increasing field strengths. Efficiencies of greater than 99 percent could be obtained from glass fiber mats using a 13 kV/cm electric field at 16.3 cm/s face velocity.

54958 (CONF-760822—P2, pp 630-661) **HEPA filter performance comparative study.** Gunn, C.A.; Eaton, D.M. (Mine Safety Appliances Co., Evans City, PA). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Current products such as HEPA filters made without separators, with tapered separators and with mini separators have raised many questions for the Nuclear Ventilation System Design Engineer and/or the end user. The principal objective of this investigation is to report HEPA filter performance data and to compare the effectiveness of the various type HEPA filters for use in Nuclear Ventilation Systems with all tests run on the same equipment and under the same controlled conditions.

54959 (CONF-760822—P2, pp 662-676) **Penetration of HEPA filters by alpha recoil aerosols.** McDowell, W.J. (Oak Ridge National Lab., TN); Seeley, F.G.; Ryan, M.T. 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The self-scattering of alpha-active substances has long been recognized and is attributed to expulsion of aggregates of atoms from the surface of alpha-active materials by alpha emission recoil energy, and perhaps to further propulsion of these aggregates by subsequent alpha recoils. Workers at the University of Lowell recently predicted that this phenomenon might affect the retention of alpha-active particulate matter by HEPA filters, and found support in experiments with ^{212}Pb. Tests at Oak Ridge National Laboratory have confirmed that alpha-emitting particulate matter does penetrate high-efficiency filter media, such as that used in HEPA filters, much more effectively than do non-radioactive or beta-gamma active aerosols. Filter retention efficiencies drastically lower than the 99.9 percent quoted for ordinary particulate matter were observed with ^{212}Pb, ^{253}Es, and ^{239}Pu sources, indicating that the phenomenon is common to all of these and probably to all alpha-emitting materials of appropriate half-life. Results with controlled air-flow through filters in series are consistent with the picture of small particles dislodged from the "massive" surface of an alpha-active material, and then repeatedly dislodged from positions on the filter fibers by subsequent alpha recoils. The process shows only a small dependence on the physical form of the source material. Oxide dust, nitrate salt, and plated metal all seem to generate the recoil particles effectively. The amount penetrating a series of filters depends on the total amount of activity in the source material, its specific activity, and the length of time of air flow.

54960 (CONF-760822—P2, pp 711-715) **Government-industry meeting on filters, media, and media testing.** Anderson, W.L. (Naval Surface Weapons Centers, Dahlgren, VA). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

The following topics were discussed by an informal working group: standardization of test methodology, microfiber diameter determination, fiber migration from HEPA filters, qualified products list (QPL) for HEPA filters, draft mil. specs. on HEPA media and units, and DOP toxicity during man testing. (TFD)

54961 (CONF-760822—P2, pp 834-835) **Ultrahigh efficiency sparkproof electrostatic precipitation.** Thompson, J.K.; Clark, R.C.; Fielding, G.H. (Naval Research Lab., Washington, DC). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Low-conductivity nonmetallic plates for two-stage electrostatic precipitators allow design improvements and simplifications such that efficiencies of 99.99+ percent appear attainable at an air speed of 250 fpm and a pressure loss of 0.1 inch of water.

54962 (CONF-760822—P2, pp 852-869) **Experimental investigation of the relationship between bed packing and flow distribution.** Parish, H.C.; Muhlenhaupt, R.C. Vogelhuber, W.W. (CVI Corp., Columbus, OH). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

A testing program was conducted to evaluate different methods for filling carbon beds in terms of the resultant air flow distribution through the beds. Three filling methods were included: (1) deposit carbon in the bed in an uncontrolled and random manner (with respect to fill rate and/or distribution) with no packing effort; (2) uncontrolled deposition as in (1) above but followed by an attempt to pack by vibration; and (3) filled and packed simultaneously, using a gravity pack method. The test results indicate that the filling method is a very significant factor in determining the quality of the resultant air flow distribution. A gravity packing method provided the best results while the uncontrolled fill with no effort to pack gave very poor results. The combination of an uncontrolled fill with subsequent packing by vibration also provided poor flow distribution.

54963 (CONF-760822—P2, pp 612-629) **Testing of air filters under quality control safety program.** Skaats, C.D. (Rockwell International, Golden, CO). 1976.

From 14. US ERDA air cleaning conference; Sun Valley, Idaho, United States of America (USA) (2 Aug 1976).

In Proceedings of the fourteenth ERDA air cleaning conference.

Testing and inspection of filters used in air filtration systems are conducted at Rocky Flats Plant under the Energy Research and Development Administration and Rockwell quality control program. Some 8,000 high efficiency particulate air (HEPA) filters purchased from three principal suppliers were examined over the year by the Filter Certification group. In facilities handling radioac-

tive materials, filters must function efficiently to provide accurate data on air contamination to safeguard personnel and the environment. Data are given on filter rejects under established criteria and on recommendations for action to the suppliers.

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 54774

54964 Filter system for processing the radioactive wastes after administration of radio-iodine for metabolic purposes. First clinical experiences. Bekier, A. (Kantonsspital Sankt Gallen (Switzerland). Nuklearmedizinische Abt.). *Kerntechnik;* **19**: No. 2, 87-89(Feb 1977). (In German).

6 figs.; 4 refs.

After medical administration of large activity doses of ^{131}I, the part of the activity which is not utilized metabolically is excreted mainly through the kidneys. In the first few days after the treatment, the urine of such patients contains dangerously high quantities of ^{131}I and cannot be released into the public sewage system. A transportable filter unit has been developed which can be set up directly in the patient's room and be used by the patient. By means of this filter unit the liquid radioactive waste is converted into a solid enclosed form with concurrent reduction in volume. This reduces the radiation exposure and hazard of contamination of the nursing staff.

TRANSPORT AND STORAGE FACILITIES

54965 Design diagrams and formulae for U-shaped bellows. Hamada, M.; Inoue, Y.; Nakatani, T.; Moriishi, M. (Osaka Univ, Suita, Jpn). *Int. J. Pressure Vessels Piping;* **4**: No. 4, 315-328(Oct 1976).

The U-shaped bellows is a type of expansion joint very widely used in pipelines. This paper presents some design diagrams and design formulae for such a bellows in a manner intended to enable the pipeline designer to evaluate more easily the elastic characteristics; maximum stress, elongation and reaction stress. 4 refs.

MINING AND DRILLING EQUIPMENT AND FACILITIES

54966 Novel rock disintegration techniques. Maurer, W.C. (Maurer Engineering Inc., Houston, TX). pp 57-76 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

Drilling equipment is described which disintegrates rock by mechanically induced stresses, thermal spalling, fusion, and chemical reactions. (JSR)

LASERS

REFER ALSO TO CITATION(S) 54021, 54457, 55501, 55504

54967 (AD-A—038628) **Pressure damping for pulsed electric discharge laser. Final report.** Kesselring, R.; March, R. (Rockwell International Corp., Canoga Park, Calif. (USA). Rocketdyne Div.). Apr 1976. Contract F29601-73-A-0034. 143p. (R—9739). NTIS PCA07/MF A01.

The electric discharge in a pulsed electric discharge laser (EDL) produces density disturbances in the gaseous medium which significantly alter the refractive index of the medium and seriously degrade laser beam quality. The use of acoustic absorbers and honeycomb flow conditioners to quickly damp the disturbances in the EDL has shown promise. An experimental study was conducted to further investigate the use of acoustic absorbers and honeycomb flow conditioners as attenuation devices in pulsed EDLs. A plexiglass model of a typical EDL, full scale in two cavity dimensions, was used for the experimental evaluations. This model was readily varied to provide for: (1) various aperture area and resonator volume acoustic absorbers behind the 'anode' area, (2) the addition of CERCOR (glass ceramic) thicknesses of 0.5 inch and 3.0 inches in the flow channels immediately upstream and downstream of the cavity, and (3) various types of flow duct terminations (i.e., open, closed, partially closed, and plenum closed). The discharge was simulated with an explosive charge, and pressure oscillation damp times were determined for various model configurations. A total of 200 pulse tests was conducted on various model configurations. An analysis of AFWL data and the Rocketdyne acoustic model data led to the conclusion that laser cavity modes (2 to 3 kHz) exert relatively little influence in the attenuation of the pressure oscillation. The predominant frequency apparent in the data (less than 1 kHz) is related to flow channel modes.

54968 (AD-A—038667) **The effect of turbulence on laser beam quality. Final report Mar 73—Aug 76.** Rivir, R.B. (Air Force Aero-Propulsion Lab., Wright-Patterson AFB, Ohio (USA)). Nov 1976. 221p. (AFAPL-TR—76-94). NTIS PCA10/MF A01.

Helium-neon and helium-cadmium laser beams were propagated through a turbulent medium and the mean laser beam intensity and power profiles were measured in the focal plane. The effect of ranges of the ratios of integral and micro scales of turbulence to laser beam diameter and ranges of turbulence intensities which are typical of laser cavities are reported. The experimental measurements are compared with analytical predictions of Chernov and Sutton showing that the uncertainty in predicting laser beam spread in the presence of random fluctuations has been reduced by a factor of at least 2.

54969 (AD-A—038792) **Monolithic laser. Annual technical report No. 3, 1 May 75—31 Jan 77.** Lawley, K.L.; Bellavance, D.W.; Campbell, J.C. (Minnesota Univ., Minneapolis (USA). Dept. of Civil and Mineral Engineering). Mar 1977. Contract N00014-73-C-0288. 69p. (TI—08-77-12). NTIS PCA04/MF A01.

The accomplishments of the third phase of the research program to develop the first prototype integrated optical transmitter are described. A new monolithic laser structure called an I-bar mesa laser was demonstrated. This double heterojunction GaAs/GaAlAs laser was grown by selective liquid phase epitaxy. The best devices operated at 525 mA drive current with a pulsed, 300 K threshold current density of 7.5 kA/sq cm. Methods of fabricating these devices are discussed. Also, various types of grown waveguides including bends and Y's were demonstrated. For bends, a 3 dB signal attenuation is observed at a radius of curvature of approximately 1.3 mm (50 mils). This radius appears to be a practical lower limit for integrated optical circuit waveguides. The I-bar mesas were combined on a chip with a grown three-layer waveguide. Measured intensity of light transmitted by end-firing from the laser through the curved waveguide was 35% of the laser emission with a narrowband output. Also, etched double heterojunction mesa laser structures were fabricated on underlying waveguides. The emission from these lasers was evanescently coupled to this guide. A coupling of 25% of the laser emission to the guide was observed.

54970 (AD-A—038820) **Unstable resonator theory. Final report.** Scully, M.O.; Moore, G.T.; McCarthy, R.J. (Arizona Univ., Tucson (USA). Optical Sciences Center). Mar 1977. Contract F29601-75-C-0088. 92p. NTIS PCA05/MF A01.

Research on unstable resonator theory is presented in three parts. Section I gives an overview of the work. In Section II a simple model is described for estimating the intensity distributions inside and emerging from lasers with high-Fresnel-number unstable resonators. In Section III modes of strip confocal unstable resonators containing spatially dependent gain are determined by means of a theory that is practical even at large Fresnel numbers.

54971 (AD-A—039010) **Modeling of turbulent mixing and reactions in chemical lasers. Final report 1 Oct 74—30 Nov 76.** Varma, A.K.; Fishburne, E.S.; Beddini, R.A. (Aeronautical Research Associates of Princeton, Inc., N.J. (USA)). Jan 1977. Contract F44620-75-C-0026. 85p. NTIS PCA05/MF A01.

A complete second-order closure program for the investigation of compressible, turbulent, reacting shear layers was developed. The equations for the means and the second-order correlations are derived from the time-averaged Navier-Stokes equations. The equations contain third- and higher- order correlations, which have to be modeled in terms of the lower-order correlations. The program uses fluid mechanical turbulence models developed over the last two decades.

54972 (AD-D—003607) **Franz-keldysh effect tuned laser.** Hughes, R.S. (Environmental Protection Agency, Denver, Colo. (USA)). 9 Nov 1976. 4p.

Supersedes PAT-APPL-563 264-75, AD-D—000640.

A tunable laser is described having a laser material capable of being tuned such as an organic dye. The tuning device includes an intra-cavity semiconductor element to which an electric field can be applied, and an angle sensitive filter or reflector such as a diffraction grating.

54973 Potential hydroxyl ultraviolet laser. Chen, C.H.; Payne, M.G. (Oak Ridge National Lab., TN). *Opt. Commun.;* **18**: No. 4, 476-478(Sep 1976).

A strong emission band extending from 3060 to 3120 A was observed following proton beam excitation of an Ar—H_2O mixture. This emission band was assigned to the transition of OH(A ²Sigma⁺)/sub nu=o/ yields OH(X ²Pi)/sub nu=o/. At high argon partial pressure (< 200 torr), the precursor of this emission band is believed to be the argon excimer Ar/sup *⁄₂(1/sub u/). The fluorescence efficiency of Ar—H_2O is estimated to be a factor of 4 times that of Ar—N_2. Development of a highly efficient, tunable uv laser by e-beam pumping is promising.

54974 Effect of the rotational relaxation rate on the operation of a pulsed H_2+F_2 chemical laser. Vasil'ev, G.K.; Makarov, E.F.; Ryabenko, A.G.; Tal'roze, V.L. (Division of the Institute of Chemical Physics, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **44**: No. 4, 690-693(Oct 1976).

The effect of the rotational relaxation rate on the characteristics of an H_2+F_2 chemical laser with HF as the active molecule is analyzed. Two limiting cases are considered: the case of rotational equilibrium, and the case of "frozen" rotational relaxation. The part played by vibrational relaxation processes is examined. It is shown that the maximum efficiency of the chemical laser is higher in the case of rotational equilibrium than in the case of frozen rotational relaxation.

54975 Method and device for synchronous generation and amplification of tunable vuv laser radiation. Waynant, R.W. US Patent 3,991,387. 9 Nov 1976. Filed date 19 Nov 1975. 5p.

Supersedes PAT-APPL-633 518-75, AD-D—002060.

A device and method for synchronous generation and amplification of tunable vuv laser radiation is presented. The system makes use of flat plate conductors which contain first and second parallel spaced channels therein.

54976 Stabilized YAG:Nd^{3+} laser with longitudinal-mode locking. Galkin, S.L.; Kruzhalov, S.V.; Nikolaev, V.M.; Pakhomov, L.N.; Petrun'kin, V.Y. (M. I. Kalinin Leningrad Polytechnical Institute). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 1, 7(Jan 1977).

Measurements are performed on the stabilization of the phase-locked multimode regime in a YAG=Nd^{3+} laser. It is found that a change in the frequency of the loss modulation in the locking band is accompanied by changes in the output pulses and modes.(AIP)

54977 CO_2—air laser with high pulse rate. Kozlov, G.I.; Korablev, A.S. (Institute for Problems of Mechanics, Academy of Sciences of the USSR, Moscow). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 1, 9-10(Jan 1977).

An electric-discharge-pumped gasdynamic open-cycle laser is described. The laser uses a CO_2-air mixture operating at a high repetition rate. A double discharge is employed while the pumping is done by an electric field in the decaying plasma.(AIP)

54978 Laser with adjustable pulse shape. Kryzhanovskii, V.I.; Parfenov, V.A.; Serebryakov, V.A.; Chertkov, A.A. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 1, 13-14(Jan 1977).

Details are given of the construction of a neodymium-glass laser system that employs electrooptical deflectors to convert a given temporal profile of the output radiation into a desired spatial-temporal distribution.(AIP)

54979 Compact 1-kJ electron-beam-pumped CO_2 laser. Orishich, A.M.; Ponomarenko, A.G.; Posukh, V.G.; Soloukhin, R.I.; Shalamov, S.P. (Institute of Theoretical and Applied Mechanics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 1, 16-17(Jan 1977).

The results are presented of an experimental study of a compact CO_2 laser for which the energy source is a high-voltage generator with a low internal resistance.(AIP)

54980 Experimental study of a fast-flow cw CO laser. Abrosimov, G.V.; Dymshits, B.M.; Ivanov, G.V.; Koretskii, Y.P.; Lamonov, V.M.; Sharkov, V.F. (Scientific-Research Institute of Nuclear Physics, Moscow). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 1, 135-136(Jan 1977).

The energy and spectral properties of a cw CO laser with a longitudinal electic discharge is studied. The output power is measured as functions of flow rate and pressure.(AIP)

54981 Characteristics of stimulated light generation and stimulated Raman scattering in anthracene crystals. Avanesyan, O.S.; Benderskii, V.A.; Brikenshtein, V.K.; Broude, V.L.; Lavrushko, A.G.; Tartakovskii, I.I.; Filippov, P.V. (Institute of Chemical Physics, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 4, 403-405(Apr 1977).

Nonlinear optical phenomena in anthracene single crystals were investigated by focusing exciting radiation into a stripe of dimensions and direction corresponding to the dimensions and direction of the optically most homogeneous channels in a crystal. The intensity of stimulated emission in the 23 692 cm^{-1} band in such a channel exceeded 2 x 10^8 W/cm^2. Two Stokes components of stimulated Raman scattering were observed under these conditions: they were due to the scattering of the stimulated radiation excited in a crystal by an intramolecular vibration of 1403 cm^{-1} frequency.

54982 Spectral-correlation study of fluctuations of the intensity of 0.63 μ radiation emitted from an He—Ne laser. Gus'kov, L.N.; Sologub, V.P.; Troshin, B.I. (Institute of Semiconductor Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 4, 406-409(Apr 1977).

A spectral-correlation experimental study was made of the fluctuations of the intensity of emission from a helium—neon laser. This study included measurements of the spectral power density of fluctuations of the emission intensity and discharge current, as well as measurements of the transfer coefficient and coefficient of mutual correlation between the current and emitted light. The measurements were carried out in the frequency range of discharge current fluctuations. The spectral power density of fluctuations of the radiation intensity was calculated. A qualitative analysis was made of the results obtained.

54983 Angular correction of the radiation emitted from a laser with an inhomogeneous active medium. Belousova, I.M.; Bobrov, B.D.; Danilov, O.B.; Kiselev, V.M.; Kurzenkov, V.N.; Novoselov, N.A.; Spiridonov, V.V.; Trofimov, N.P. *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 4, 418-421(Apr 1977).

An experimental comparison was made of a plane-parallel resonator containing a telescopic angular selector with an unstable telescopic resonator. The resonator with a telescopic angular selector made it possible to achieve for the first time a considerable reduction in the angular divergence of the radiation emitted from a moving stimulated emission zone.

54984 Self-locking of laser modes. Landa, P.S.; Vygodin, V.A. (M. V. Lomonosov State University, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 4, 428-431(Apr 1977).

An analytic investigation is made of the conditions for self-locking of laser modes. It is based on a system of reduced equations in terms of partial derivatives of the field amplitudes and polarizations and in terms of the difference between the populations of the active levels. The shape of the field pulses under mode-locked conditions is calculated. The results of these calculations are applicable to ring gas lasers and to solid-state lasers with homogeneously broadened lines.

54985 Theoretical investigation of the emission characteristics of an electron-beam-controlled CO laser. Basov, N.G.; Dolinina, V.I.; Suchkov, A.F.; Urin, B.M. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 4, 432-435(Apr 1977).

A study is made of the spectral, threshold, and energy characteristics of an electron-beam-controlled CO laser emitting long (10^{-6}-10^{-3} sec) pulses. The study is based on a numerical solution of a system of rate equations which describe the populations of the vibrational levels of the CO molecule, stimulated emission as a result of transitions between these levels, and changes in the rotational-translational temperature of the gas.

54986 Single-frequency garnet lasers with waveguide resonators. Glushchenko, N.F.; D'yachenko, V.V.; Mikaelyan, A.L.; Tsarev, P.P. *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 4, 436-437(Apr 1977).

The results are given of an experimental investigation of laser garnets with waveguide resonators. The use of such resonators made it possible to eliminate the influence of thermooptic distortions and to obtain highly coherent radiation.

54987 Influence of inhomogeneities of the flow parameters on the characteristics of active media of CO_2 and N_2O gasdynamic lasers. Biryukov, A.S.; Serikov, R.I.; Starik, A.I.; Shelepin, L.A. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 4, 438-441(Apr 1977).

Allowance is made for the two-dimensional nature of the flow in gasdynamic lasers. It is shown that inhomogeneities of the gas flow parameters deduced from the one-dimensional model may lead to a considerable (20-30%) inhomogeneity of the gain across the nozzle. The transverse distribution of the gain depends also on the kinetics of the vibrational processes in the gas and it is quite different for N_2O and CO_2 lasers.

54988 Identification of active transitions in a formic acid vapor laser. Baskakov, O.I.; Dyubko, S.F.; Moskienko, M.V.; Fesenko, L.D. (A. M. Gorki State University, Kharkov). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 4, 445-449(Apr 1977).

Fourteen lines were identified in the submillimeter emission spectrum of an HCOOH molecular laser pumped by CO_2 laser radiation. This was done by investigating experimentally the rotational spectrum of the ν_6 and ν_9 excited states in the 300—400 GHz range. The identified pump transitions and the known CO_2 laser frequencies made it possible to determine the central frequencies of the ν_9 (33 122 609 MHz) and ν_9 (31 982 778 MHz) bands to within +- 50 MHz. It was found that the ν_6 and ν_9 vibrational states interacted. Identification was also performed by a double resonance method which did not require a study of the rotational spectra of excited vibrational states.

54989 Photoionization in pulse CO_2 laser. Borisov, V.M.; Gladush, G.G.; Stepanov, Y.Y. *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 4, 450-453(Apr 1977).

Measurements were made of the density of photoelectrons in He, N_2, and CO_2—N_2—He mixtures created by a planar ultraviolet radiation source ensuring a bulk discharge in a real CO_2 pulse laser. The experiments and calculations demonstrated that the photoelectron density in laser mixtures and its behavior as a function of the distance from the ultraviolet radiation source were governed by the ionization of impurities with low ionization potentials present in the gas and by the absorption of the radiation in the CO_2 molecules. Introduction of optimal numbers of such impurities (xylene and dimethyl aniline) made it possible to increase the photoplasma density by more than one order of magnitude; under these conditions the photoplasma decayed by recombination at a rate represented by the recombination coefficient 10^{-5} cm^3 sec^{-1}.

54990 Ranges of existence and stability of two-mode stimulated emission from a mode-locked ring laser with two-isotope active medium. Sokolov, V.A.; Filatov, P.P. (Scientific-Research Physics Institute at the A. A. Zhdanov State University, Leningrad). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 460-464(Apr 1977).

The ranges of existence and stability of two-mode stimulated emission from a ring gas laser with a two-isotope active medium are investigated theoretically as a function of various laser parameters. The analysis is made using a complete system of amplitude and phase equations and the normal oscillation method. It is shown that a stable steady-state value of the difference between the phase shifts of the two modes in the opposite waves may lie in the interval $(0, 2\pi)$ but need not be close to 0 or π. The actual value of this difference between the phase shifts is governed by the ratios of the backscattering coefficients and relative Q factors to the coefficients of the combination interaction of different modes of the opposite waves.

54991 Mode self-locking in a laser with combined Q switching. Al'tshuler, G.B.; Karasev, V.B.; Sharlai, S.F. (Institute of Precision Mechanics and Optics, Leningrad). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 487-488(Apr 1977).

An experimental investigation was made of the feasibility of achieving mode self-locking in a neodymium-glass laser with combined Q switching by optomechanical and phototropic modulators. A study was made of the characteristics of the output radiation and it was found that mode self-locking was achieved on introduction of an additional semitransparent mirror into the resonator. The attainment of self-locking under combined Q-switching conditions reduced the number of ultrashort pulses in the output and stabilized the beginning of stimulated emission.

54992 Laser radiation source for practical interferometry. Nazarenko, M.M.; Rybakov, B.V.; Serebryakov, G.S.; Skulachenko, S.S.; Yudin, I.I. *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 489-490(Apr 1977).

A study was made of a stabilized laser source based on a two-mode helium—neon ring laser with a circularly anisotropic resonator. This laser emitted at 0.63 μ. The frequency was stabilized by comparing the frequencies of the Zeeman beats between the orthogonal modes of the opposite waves. The relative frequency stability achieved in this way was 8.8×10^{-12} in an averaging time of 1 min.

54993 Modulation method for determination of the degree of excitation of a gas laser. Akchurin, G.G.; Mel'nikov, L.A.; Tuchin, V.V. (Scientific-Research Institute of Mechanics and Physics at the N. G. Chernyshevskii State University, Saratov). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 493-494(Apr 1977).

A modulation method for the determination of the relative excitation of a single-mode gas laser was developed and tested experimentally. The method has the advantage that no independent measurements of the temperature of the active substance are required.

54994 Neodymium-glass disk laser amplifier with an immersion medium. Bondarev, A.S.; Buchenkov, V.A.; Vakhmyanin, K.P.; Venglyuk, V.I.; Volynkin, V.M.; Ivanushkina, L.V.; Korolev, V.I.; Sedov, B.M.; Stepanov, A.I. *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 501-502(Apr 1977).

A description is given of a laser amplifier with a disk active element made of GLS2 (40 x 40 x 220 mm dimensions). This amplifier is filled with thionyl chloride ($n=1.53$, absorption coefficient $k<10^{-3}$ cm^{-1} at $\lambda=1.06$ μ). The single-pass inactive losses, per 1 cm length of the active medium, are 4.3×10^{-3} cm^{-1}. The results are reported of measurements of the small-signal gain and of the gain obtained at pump energy densities up to 25 J/cm^3.

54995 Pulse-periodic CO_2 laser with a non-self-sustaining discharge. Bugaev, S.P.; Bychkov, Y.I.; Koval'chuk, B.M.; Kurbatov, Y.A.; Manylov, V.I.; Mesyats, G.A.; Orlovskii, V.M. (Institute of Atmospheric Optics, Siberian Branch, Academy of Sciences of the USSR, Tomsk). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 503-504(Apr 1977).

A report is given of the parameters of a pulse-periodic CO_2 laser with an active volume of 0.8 liter and a non-self-sustaining discharge. A description is given of a gas-pumping system, a power supply of the main discharge gap, and an electron accelerator producing a ribbon-like (40 x 500 mm) electron beam of 4 A/cm^2 current density and 36 nsec pulse duration. The specific output power of this laser was up to 150 W/liter, the pulse repetition frequency up to 16 Hz, and the pulse energy up to 10 J.

54996 Suppression of stimulated emission in the phonon wing of a naphthalene crystal with $\beta\beta'$-dinaphthylethylene impurity by an off-resonance field. Zinov'ev, P.V.; Naboikin, Y.V.; Ogurtsova, L.A.; Podgornyi, A.P.; Silaeva, N.B. (Physicotechnical Institute of Low Temperatures, Kharkov). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 505-506(Apr 1977).

An investigation was made of the 4.2°K stimulated emission spectrum of a naphthalene crystal with a high concentration of $\beta\beta'$-dinaphthylethylene when this crystal was illuminated with off-resonance radiation. The crystal was excited by the third harmonic of a neodymium laser ($\lambda=0.35$ μ) and the off-resonance radiation was the second harmonic of the same laser ($\lambda=0.53$ μ). Simultaneous illumination with the $\lambda=0.35$ μ and $\lambda=0.53$ μ radiation resulted in a strong reduction in the intensity of stimulated radiation emitted at a frequency in the phonon wing. This effect was attributed to the Raman scattering of the $\lambda=0.53$ μ radiation by nonequilibrium phonons.

54997 Multicomponent solid solutions of IV-VI compounds. Davarashvili, O.I.; Dolginov, L.M.; Eliseev, P.G.; Zasavitskii, I.I.; Shotov, A.P. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 508-510(Apr 1977).

An analysis is made of the possibility of using multicomponent solutions of IV-VI compounds in laser heterostructures free of lattice mismatch and associated defects and stresses. Characteristics of a PbSe—PbSnTeSe at $\lambda=10$ μ, are estimated. The relative jump in the refractive index needed for optical confinement is estimated to be 8%.

54998 Stimulated emission due to transitions in copper atoms formed in transverse discharges in copper halide vapors. Abrosimov, G.V.; Vasil'tsov, V.V. (Scientific-Research Institute of Nuclear Physics at the M. V. Lomonosov State University, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 512-513(Apr 1977).

Stimulated emission as a result of self-terminating transitions in the copper atom was observed in discharges in copper chloride and iodide. Pairs of discharge pulses were applied to a quartz tube with a heated zone 400 mm long and 20 pairs of electrodes. Neon was used as the buffer gas. The dependence of the peak output power on the separation in each pair of pulses was determined. The specific energy output per pulse was 50 μJ/cm^3 for CuCl and 40 μJ/cm^3 for CuI; these values were higher than those obtained by other authors in transverse discharges.

54999 Laser resonator for far vacuum ultraviolet. Ilyukhin, A.A.; Peregudov, G.V.; Ragozin, E.N.; Chirkov, V.A. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 519-520(Apr 1977).

The construction of a resonator for the λ300—700 A range is discussed. A description is given of two normal-incidence resonators in which radiation is coupled out either through a slit in a mirror or by a diffraction grating (in a nonzero diffraction order). It is shown that the use of laser plasma as the active medium imposes stringent requirements on the optical strength of the resonator mirrors.

55000 Amplification and generation of stimulated radiation in a quartz fiber. Gorovaya, B.S.; Demskaya, E.L.; Izotov, A.N.; Konarev, V.P.; Kondrat'ev, Y.N.; Matveev, I.N.; Prokhorova, T.I.; Tabrin, V.N.; Shevelevich, R.S. *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 521-522(Apr 1977).

An experimental investigation was made of the amplification of $\lambda=1.06$ μ radiation in a 2500-mm long Nd^{3+}-activated quartz fiber. Stimulated emission was observed when the pump energy was 180—200 J and it was accompanied by a weak spontaneous noise. When the threshold was exceeded by a factor of 2, the gain rose to 7×10^4.

55001 Controlled flashlamp-illuminated phototropic switch. Balenko, V.G.; Gerasimov, B.G.; Podgaetskii, V.M.; Slivka, L.K. *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 530-532(Apr 1977).

An investigation was made of a controlled phototropic switch which was initially bleached by flashlamps. Characteristics were determined of switches employing phthalocyanines Pc'GaCl (in ethanol) and Pc'H_2 (in polymethylmethacrylate). The ranges of switch control were studied and the parameters of a ruby laser with a switch of this kind were determined. An investigation was made of the influence of a flashlamp pulse on the time of appearance of a giant stimulated emission pulse.

55002 Nuclear-pumped laser research. Russell, G.R. (Jet Propulsion Lab., Pasadena, CA). *Trans. Am. Nucl. Soc.;* 26: 529-530(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55003 Present and future problems concerning lasers in the far-infrared spectral region. Coleman, P.D. (Electro-Physics Laboratory, Department of Electrical Engineering, University of Illinois, Urbana, Illinois 61801). *J. Opt. Soc. Am.;* **67**: No. 7, 894-901(Jul 1977).

Basic problems of far infrared molecular lasers are discussed with respect to present and future developments. The topics of interest are those of excitation methods, molecular physics, energy exchange and relaxation processes, resonator design, and laser modeling and analysis. While great strides have been made in far-infrared molecular laser research in the last seven years, it is concluded that present efforts are largely in the exploratory stage and that detailed understanding and development of the area is still in the future.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 54340, 54366, 54449, 54455, 54456, 54628, 54727

55004 (BNL-NUREG—22904) **Interfacial passage frequency for two-phase, gas-liquid flows in narrow rectangular ducts.** Jones, O.C. Jr.; Zuber, N. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 6p. (CONF-770904—3). Dep. NTIS, PC A02/MF A01.

From TDFM group meeting on heat fluid flow in water reactor safety; Manchester, United Kingdom of Great Britain and Northern Ireland (UK) (13 Sep 1977).

Hydrodynamic and thermal transfer and relaxation phenomena in two-phase gas-liquid flows are strongly dependent on departure from equilibrium and the interfacial area density available for phase interactions. Such interactions include mass, momentum, and energy exchange for which the transfer coefficient must be accuratey known as well as the area available for interactions to occur. The direct measurement of interaction interfacial area density is an exceedingly difficult task in view of today's knowledge. On the other hand, knowledge of the interfacial passage frequencies coupled with information regarding the flow structure would enable a model to predict the area densities reasonably well. Such information has been obtained using a sub-miniature, hot-film anemometer in air-water flows at velocities up to approximately 25 m/s. These data include bubbly, slug, annular, and annular mist flows. The method, the data, and certain conclusions regarding the flow structure, particularly regarding the nature of roll waves in narrow ducts are discussed.

55005 Direct measurement of the void fraction of a two-phase fluid by nuclear magnetic resonance. Lynch, G.F. (Atomic Energy of Canada Ltd, Chalk River, Ont.); Segel, S.L. *Int. J. Heat Mass Transfer;* **20**: No. 1, 7-14(Jan 1977).

Application of nuclear magnetic resonance (NMR) to the direct measurement of void fractions of two-phase fluids has been studied. With this technique, the effective density of the fluid is determined by monitoring the NMR signal strength from a particular nuclear species in the liquid. The results, from experiments on both static and flowing systems, establish the linearity of the method for the full range (0 yields 1) of void fractions, independent of the mass distribution of the liquid, and demonstrate the feasibility of using NMR as a direct method for void-fraction measurements in two-phase systems.

55006 Laminar film condensation of flowing vapor on a horizontal melting surface. Cho, D.H.; Epstein, M. (Argonne National Lab., IL). *Int. J. Heat Mass Transfer;* **20**: No. 1, 23-30(Jan 1977).

Laminar film condensation of a saturated vapor flowing over a horizontal melting surface is studied analytically. Using an approximate treatment of the shear stress at the vapor-liquid interface (as suggested by Shekriladze and Gomelauri), the similarity conservation equations are solved numerically. Solutions for the condensation rate, melting rate and skin friction are obtained for three values of the liquid Prandtl number (0.1, 1 and 10) and for a wide range of condensation and melting parameters (Stefan numbers). The solutions become exact as the parameter [(rho μ)/(rho/sub v/μ/sub v/)]/sup ½/ goes to infinity. Simple analytical solutions based on a thin-film approximation are also derived and compared with the numerical results.

55007 Pool heat transfer to liquid and supercritical helium in high centrifugal acceleration fields. Scurlock, R.G.; Thornton, G.K. (Univ. of Southampton, Eng.). *Int. J. Heat Mass Transfer;* **20**: No. 1, 31-40(Jan 1977).

In relation to the problem of cooling the rotating field windings of a superconducting alternator, a preliminary experimental study of pool heat transfer to helium under high speed rotation is reported. Heat transfer from a flat copper surface has been measured for a range of heat flux from 0.2 to 650 mW/cm^2 and in local centrifugal acceleration fields of from 180 to 1720 g perpendicular to the surface. Analysis of the data indicates that the mode of heat transfer by free convection at both subcritical and supercritical pressures follows the simple correlation $Nu = 0.29\ Ra^{0.39}$. At subcritical pressures, nucleate boiling is an additional process at sufficiently high heat fluxes.

55008 Natural convection in a volumetrically heated fluid layer at high Rayleigh numbers. Cheung, F.B. (Argonne National Lab., Evanston, Ill. (USA)). *Int. J. Heat Mass Transfer;* **20**: No. 5, 499-506(May 1977).

A phenomenological model of eddy heat transport in natural convection with volumetric energy sources at high Rayleigh numbers is developed. The model is applied to the problem of thermal convection in a horizontal heated fluid layer with an adiabatic lower boundary and an isothermal upper wall. A correlation for mean Nusselt numbers is obtained for steady heat transfer. Distributions of the mean turbulent temperature, the eddy heat flux, and production of thermal variance in the heated fluid are presented. The mechanism of turbulent thermal convection at high Rayleigh numbers is discussed. Comparison with existing experiments is good.

55009 Analysis of heat transfer by natural convection across vertical fluid layers. Raithby, G.D.; Hollands, K.G.T.; Unny, T.E. (Thermal Engineering Group, Department of Mechanical Engineering, University of Waterloo, Waterloo, Ontario, Canada, Mem. ASME). *J. Heat Transfer;* **99**: No. 2, 287-293(May 1977).

An analysis is presented which predicts the heat transfer across fluid layers bounded laterally by vertical isothermal surface and adiabatic surfaces on the top and bottom. The vertical temperature distribution in the core of the cavity is also predicted. Extensive comparisons of average Nusselt number and temperature distribution are made with experimental data for aspect ratios greater than 5. Good agreement between analysis and experiment is found. The heat-transfer equations for vertical layers are generalized to include layers which are tilted up to 20degree from the vertical, making the results useful for the design of solar collectors.

55010 Experimental and analytical study of transient heat ransfer for turbulent flow in a circular tube. Kawamura, H. (Japan Atomic Energy Research Inst., Tokai). *Int. J. Heat Mass Transfer;* **20**: No. 5, 443-450(May 1977).

A circular tube cooled by constant turbulent flow of water was heated stepwise with time. Variation of heat-transfer coefficient was obtained. When the tube was heated prior to the step increase of heat input, a maximum appeared in the variation of heat-transfer coefficient. Reason for the maximum is discussed. Numerical analysis is made for the same configuration as that of the experiment. The numerical results agree well with the experimental ones. An analytical expression for the variation of heat-transfer coefficient is obtained. Time required for the heat-transfer coefficient to reach steady state is studied.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 55012

55011 Modulated-grating hologram. MacQuigg, D.R. (Univ. of California, Livermore). *Appl. Opt.;* **16**: No. 5, 1380-1389(May 1977).

By means of a multiple-exposure holographic recording method, a phase-and-amplitude, off-axis hologram, which we call a modulated-grating hologram, has been synthesized from three computer-generated transmission masks. Each mask controls one fixed-phase component of the complex hologram transmittance. The basic grating is generated optically, relieving the computer of the burden of drawing details the size of each fringe. The maximum information capacity of the computer plotting device can thus be applied to the generation of the grating modulation function. Large digital holograms (25 mm x 25 mm) have been synthesized by this method in dichromated gelatin. The method can be used with virtually any holographic recording medium. It was designed primarily for spatial filtering applications, in which a hologram with large dynamic range and large free-spectral-range is needed.

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 55046

55012 (COO—4002-3) **Evaluation of methods for increasing vacuum breakdown strength.** Evans, R.D.; Cooke, C.M.; Berman, E.R. (Ion Physics Corp., Burlington, Mass. (USA); Massachusetts Inst. of Tech., Cambridge (USA)). Jan 1977. Contract EY-76-C-02-4002. 90p. Dep. NTIS, PC A05/MF A01.

Research to determine the effectiveness of coated and gas shielded cathodes as a means of increasing vacuum breakdown strength under short pulse conditions is reported. A technique for rapidly evaluating large numbers of coatings on small electrodes at relatively low pulse voltage (120 kV or less) and methods for testing larger electrodes and fewer coatings at higher total voltage were developed. Experiments with gas shielded cathodes were also conducted. Results suggest that it may be possible to eliminate prebreakdown current and to double breakdown strength by applying a suitable coating to the cathode. Breakdown stresses in excess of 2 MV/cm were obtained in a 0.5 mm gap with sputtered coatings of alumina, Cr_2O_3, and several readily available epoxies. Electrodes two orders of magnitude greater in area were tested, and stresses approaching 1 MV/cm were measured in 5 mm gaps for several epoxies and for alumina. It has further been shown that, because similar trends occurred in the data from large and small experiments, it should be possible to screen potential coatings rapidly and effectively with minimum expenditure using a method similar to that employed for small electrodes at low pulse voltage.

55013 (SAND—76-0643) **Complexity vs performance in digital filters.** Stearns, S.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1977. Contract E(29-1)-789. 18p. Dep. NTIS $3.50.

Data plots are presented to help select the appropriate digital filter for a given application. These plots are applicable to the Butterworth and Chebyshev filters, and are useful in choosing a filter on the basis of one or more of the following criteria: cutoff characteristics, rise time, overshoot, and impulse response time. 6 figures.

55014 (UCRL—78932(Rev.1)) **Rectangle-probe router for multilayer PC boards.** Cage, W.G.; Smith, R.J. II. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Mar 1977. Contract W-7405-ENG-48. 11p. (CONF-770610—2). Dep. NTIS, PC A02/MF A01.

From 14. ACM-IEEE design automation conference; New Orleans, Louisiana, United States of America (USA) (20 Jun 1977).

An effective implementation of a rectangle probe interconnection routing algorithm is described. The router successfully handles multilayer boards with foil conducting paths of various widths. Connections defined by the router may utilize one or more conducting layers. Objectives to be achieved by the router are discussed, and implementation features related to these requirements are presented; data and control structures are briefly described. Routing performance and experiments indicating sensitivity to variations in algorithm or problem definition are presented. The subject router is in production use as part of the DASLL design automation system at Lawrence Livermore Laboratory. 18 figures, 2 tables.

SOLID WASTE PROCESSING PLANTS AND EQUIPMENT

REFER ALSO TO CITATION(S) 54754

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 53811, 53815, 53862, 53930, 53931, 54224, 54799

55015 **Flywheel magneto having capactive ignition system.** Carlsson, H.T.H. (to Aktiebolaget Svenska Electromagneter). US Patent 4,019,485. 26 Apr 1977. Priority date 3 Dec 1971, Sweden. 6p.

This invention provides an improvement in a flywheel magneto having a thyristor controlled capacitive ignition system including a flywheel having permanent magnets and at least one cooperating coil core which has three pole legs and at least one charging coil and one trigger coil. The improvement comprises a charging coil arranged on the intermediate pole leg of the coil core and a trigger coil being arranged on the last pole leg when viewed in the direction of rotation of the flywheel.

55016 **Automatic fuel ignition apparatus.** Sears, A.H.; Siuta, A.J. Jr. (to Carborundum Co.). US Patent 4,019,853. 26 Apr 1977. Filed date 3 Nov 1975. 8p.

An apparatus for fluid fuel ignition consists essentially of an igniter which reaches a temperature above the ignition temperature of the fuel when sufficient electricity from an electrical source passes through the igniter and which igniter remains continuously at a temperature above the ignition temperature of the fuel while the fuel passes through a fuel injection means proximate to the igniter. A thermal delay relay which activates a valve, which permits fuel to pass through the fuel injection means proximate the igniter, is responsive to current flow through the igniter after the igniter has reached ignition temperature. The apparatus requires no mechanical moving parts other than a thermostat, one electrical relay and a fuel valve responsive to an electrical signal. Only two sets of electrical contacts are required in the entire apparatus including the thermostat and internal relay contacts. The apparatus may be conveniently designed to operate at either low or high voltage. A low voltage thermostatic control may optionally be used in conjunction with a high voltage ignition which requires only one additional relay.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 53748

55017 **Trends in rapid excavation research and development.** Hakala, W.W. (National Science Foundation, Washington, DC). pp 83-86 of In Resource recovery. Albuquerque, NM; American Society of Mechanical Engineers (1975).

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

See CONF-750306—.

Excavation R and D is discussed from the aspects of projected demand for underground excavation, public and private sector interest involvement, coordination of R and D activities, priorities, and expenditures. (JSR)

MARINE ENGINEERING

55018 **Practical underwater training for divers.** Bailey, V. *Pet. Rev.;* **30**: No. 360, 649, 651(Dec 1976).

The Underwater Training Centre at Fort William, Scotland, is the first specialist civilian center to train underwater workers. The Center can provide all year round lockout dives and associated practical underwater work in depths of at least 150 meters in sea water. It can maintain up to 12 people in continuous saturation. With three deck decompression chambers and a tranfer lock it is designed to provide any combination of simultaneous saturation, bounce and therapeutic facilities and can also be used for any purpose where a saturation or bounce depth is the required basis of the environment under investigation. Financial supports, training philosophy and methods are summarized.

55019 **Offshore water services.** Bedford, B.P. *Chem. Eng. (London);* No. 321, 397-402(Jun 1977).

The sources of water available, the types of service water systems required on a platform, and finally the disposal of used and waste water are described. (DLC)

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

REFER ALSO TO CITATION(S) 55028

55020 (AD-A—038737) **A report on the status of linear collective ion acceleration with intense relativistic electron beams. Final report.** Miller, R.B. (Air Force Weapons Lab., Kirtland AFB, N.Mex. (USA)). Mar 1977. 28p. (AFWL-TR—76-169). NTIS PCA03/MF A01.

The state of the art for linear collective acceleration, and promising new experiments are suggested.

55021 **Linear particle accelerator.** Richards, J.A. (to Raymond Lee Organization, Inc.). US Patent 4,020,384. 26 Apr 1977. Filed date 25 Aug 1975. 2p.

A linear particle accelerator which provides a pulsed beam of charged particles of uniform energy is described. The accelerator is in the form of an evacuated dielectric tube, inside of which a particle source is located at one end of the tube, with a target or window located at the other end of the dielectric tube. Along the length of the tube are externally located pairs of metal plates, each insulated from each other in an insulated housing. Each of the plates of a pair are connected to an electrical source of voltage of opposed polarity, with the polarity of the voltage of the plates oriented so that the plate of a pair, nearer to the particle source, is of the opposed polarity to the charge of the particle emitted by the source. Thus, a first plate about the tube located nearest the particle source, attracts a particle which as it passes through the tube past the first plate is then repelled by the reverse polarity of the second plate of the pair to continue moving towards the target.

55022 **Field emission electron gun.** Coates, V.J.; Welter, L.M. (to American Optical Corp.). US Patent 4,020,387. 26 Apr 1977. Filed date 2 Jan 1975. 10p.

A field emission gun in which a field emission tip for generating charged particles is axially aligned with apertures in an intermediate electrode and a main electrode. A field electrode is placed in juxtaposition to the field emission tip for developing a particle generation field. This electrode is located relative to the field emission tip and the intermediate electrode to effect a predetermined focal distance and level of electron beam intensity. Use of a field electrode permits utilization of lower focusing and acceleration voltages and renders the device less sensitive to variations in field emission tip design and performance.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

55023 (AD-A—038642) **Constant radius magnetic acceleration of a strong nonneutral proton ring.** Sprangle, P.; Kapetanakos, C.A. (Naval Research Lab., Washington, D.C. (USA)). Apr 1977. 27p. (NRL—3477). NTIS PCA03/MF A01.

The constrained or constant radius magnetic acceleration of a strong, nonneutral proton ring by a modified betatron field is considered. The modified betatron field consists of a azimuthal magnetic field B(theta) superimposed on a betatron field Bz in which the 1:2 flux rule is satisfied. An important advantage of the constrained acceleration is that the energy of the nonrelativistic ions increases with the square of the magnetic field. It has been found that the orbits of the gyrating particles are stable when the self-field index ns is much greater than unity, provided that ns $<$(B(theta)/2Bz) squared at the orbit. For B(theta) = 0, the orbits are stable only in ns $< 1/2$.

55024 **Efficiency of a linear accelerator with reactive beam loading.** Lebedev, A.N.; Pazin, K.N. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 1, 80-83(Jan 1977).

Self-consistent equations are derived for the steady-state interaction of a train of point bunches with a travelling wave. These equations incorporate both the resistive and reactive loading due to the beam. These equations are solved analytically with damping at the waveguide walls taken into account. The efficiency and the utilization factor of the accelerator field are derived. These parameters are optimized in terms of the injection phase and current. The optimized values are analyzed as functions of the parameters of the system.

AUXILIARIES AND COMPONENTS

55025 **Superconductivity, cryogenics, and vacuum technology for linear accelerators.** Garwin, E.L. (Stanford Linear Accelerator Center, Calif. (USA)). *Jpn. J. Appl. Phys.;* No. Suppl. 2, 183-190(1974).

From 6. international vacuum congress; Kyoto, Japan (25 Mar 1974).

The conventional, 10^{-9} Torr-range, ion-pumped vacuum system of the SLAC 3.2-km linear accelerator is briefly described, along with typical performance data. Since polarized electron sources are of increasing importance to high-energy research, the necessary physical environments for such sources are given, and differential pumping and/or isolation systems capable of maintaining those conditions while protecting both source and accelerator are discussed. The development of microwave superconducting linear accelerators is summarized. Emphasis is on vacuum and materials processing techniques necessary to the maintenance of low surface resistance and high electric and magnetic fields. Problems remaining and prospects for their solution are briefly described, along with details of the physical processes taking place at the vacuum-metal interface.

55026 **Radiation protection design guidelines for 0.1 to 100 MeV particle accelerator facilities.** Washington, DC; National Council on Radiation Protection and Measurements (1977). 166p.

A report is given to provide design guidelines for radiation protection in particle-accelerator facilities, and to describe one or more methods by which this protection may be achieved. The recommendations given may well be modified in unusual circumstances upon the professional advice of experts with recognized competence in radiation protection for particle accelerators. The report is directed mainly to designers of accelerator facilities, and is written from an engineering point of view. It is believed that health and radiological physicists, research scientists, project engineers, technical administrators, and similar specialists will also find the information useful. The report is concerned with accelerators producing particles having energies below 100 MeV, with exceptions of all x-ray generators above 0.1 MV, all particle accelerators that can produce neutrons, and all electron accelerators with externally applied beams as low as 0.1 MeV.

EXPERIMENTAL FACILITIES AND EQUIPMENT

55027 (N—77—17840) **A preliminary area survey of neutron radiation levels associated with the NASA variable energy cyclotron horizontal neutron delivery system.** Roberts, W.K.; Leonard, R. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Dec 1976. 14p. (NASA-TM-X—73577;E—9035). NTIS, PC A02/MF A01.

The 25 MeV deuteron beam from the NASA variable energy cyclotron incident on a thick beryllium target will deliver a tissue neutron dose rate of 2.14 rad micron A-min at a source to skin distance of 125 cm. A neutron survey of the existing hallways with various shielding configurations made during operating of the horizontal neutron delivery system indicates that minimal amounts of additional neutron shielding material are required to provide a low level radiation environment within a self-contained neutron therapy control station. Measurements also indicate that the primary neutron distribution delivered by a planned vertical delivery system will be minimally perturbed by neutrons backscattered from the floor.

STORAGE RINGS

REFER ALSO TO CITATION(S) 54829

55028 **Proton—proton intersecting storage accelerator facility ISABELLE at the Brookhaven National Laboratory.** Hahn, H.; Month, M.; Rau, R.R. (Brookhaven National Laboratory, Upton, New York 11973). *Rev. Mod. Phys.;* **49**: No. 3, 625-679(Jul 1977).

The intersecting storage accelerator facility ISABELLE proposed for construction at the Brookhaven National Laboratory is reviewed. ISABELLE would permit the exploration of proton—proton collisions at center-of-mass energies continuously variable from 60 to 400 GeV and with luminosities of 10^{32}—10^{33} cm^{-2} s^{-1} over the entire energy range. The facility would consist of two interlaced rings of superconducting magnets, operating at 40 kG, in a common tunnel about 2.6 km in circumference. The proton beams would collide at six intersection regions where particle detecting systems would be located. Protons of about 30 GeV from the AGS will be accumulated in each ring to obtain the design current of 10 A prior to their acceleration to the final energy. In this paper the design philosophy underlying the principal design choices, as well as a brief description of the major accelerator systems and the conventional structures, is presented. An overview of the physics potential provided by ISABELLE is then given. The large extension of the center-of-mass energy range combined with the very high luminosity would provide unique possibilities for the investigation of the questions of greatest current interest in particle physics. Arguments, based on the available data and reasonable theoretical concepts, are presented that suggest strongly that the intermediate vector bosons required for a unified weak and electromagnetic field theory should be discovered. They should be studied in detail. The hadron production at high transverse momentum, the energy dependence of the strong interactions, and the possible search for new, massive particles are also discussed. The paper concludes with a detailed beam analysis, the various limitations on beam current, the procedures followed in optimizing the luminosity, and a justification of the projected performance levels.

INSTRUMENTATION

RADIATION INSTRUMENTATION

REFER ALSO TO CITATION(S) 54317

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 54372, 55241, 55326, 55332

55029 **Vanadium and tin as dual neutron flux monitors.** Gleason, G. (Oak Ridge Associated Universities, Inc., Tenn. (USA). Special Training Div.). *Radiochem. Radioanal. Lett.;* **26**: No. 1, 39-44(1976). 4 refs.; 2 tabs.

Foils of tin and vanadium are recommended for the determination of thermal and resonance neutron flux. These offer certain advantages over the more conventionally used monitors such as gold, manganese, indium and cobalt. A comparison of flux measurements using both conventional monitors and the V-Sn pair is shown. The results using the V-Sn monitors are consistent with those obtained from gold which includes a cadmium ratio measurement or the combination of gold and manganese. In addition, the entire procedure can be accomplished in minutes, a distinct advantage in monitoring flux of short irradiations.

55030 Biomedical probe using a fiber-optic coupled scintillator. Swinth, K.L. (Battelle Pacific Northwest Lab., Richland, WA); Ewins, J.H. *Med. Phys.;* 3: No. 2, 109-112(1976).

A high-sensitivity biomedical radiation probe which employs a fiber-optic coupled NaI(Tl) scintillator as a detector is described. It was developed for in vivo counting of low-energy ^{239}Pu photons from material located in the tracheobronchial lymph nodes. This probe is 20 times as sensitive as a solid-state probe (avalanche diode) previously developed for this application. Tests with /super 99m/Tc show a sensitivity more than 90 times greater than biomedical probes using DcTe of GaAs; however, the improved sensitivity is largely due to an increased sensitive volume. Probes were evaluated in animals and phantoms for detection of ^{239}Pu and for location of lung tumors labeled with ^{111}In.

55031 Efficiency optimization analysis for dynamic function studies with 3-D transaxial positron cameras. Eriksson, L.; Cho, Z.H. (Univ. of California, Los Angeles). *Comput. Biol. Med.;* 6: 361-372(1976).

Efficiency optimization problems for circular ring transverse axial positron camera systems (CRTAPC) have been investigated. The analyses include source activity, camera dimension, collimator and phantom sizes. The results indicate possibilities for fast dynamic function studies in the time region of a few seconds for reasonably small phantom sizes having a uniform activity distribution.

55032 Positron ring cameras for emission-computed tomography. Derenzo, S.E. (Univ. of California, Berkeley). *IEEE Trans. Nucl. Sci.;* NS-24: No. 2, 881-885(Apr 1977).

A properly designed circular ring of NaI(Tl) crystals and suitable reconstruction algorithms can provide rapid, high-resolution transverse section images of positron-labeled compounds in the human body. The spatial resolution is limited by the crystal center-to-center spacing and by the positron range in tissue. Using 280 crystals with 10-mm center-to-center spacing and isotopes such as ^{68}Ga, ^{11}C, ^{18}F, or ^{52}Fe, a resolution of 7.5 mm full width at half maximum (FWHM) is possible. Improvements in this technology will involve larger numbers of smaller crystals, more efficient crystals (possibly bismuth germanate), or faster detectors (such as loaded organic scintillators). (41 references).

55033 Technology update on fast plastic scintillators for medical applications. Lyons, P.B. (Los Alamos Scientific Lab., NM). *IEEE Trans. Nucl. Sci.;* NS-24: No. 2, 904-906(Apr 1977).

Plastic scintillators appear to have potential utility in three research areas related to nuclear medicine: (1) high count rate applications in general, (2) positron camera applications, and (3) positron source localization through measurement of relative arrival times of annihilation quanta at two co-linear detectors. These three areas of applicability depend on improvement in three specific areas of plastic scintillator technology: (a) development of plastics with very fast decay times, (b) development of plastics with greatly improved high energy photon detection efficiencies (high-Z loaded plastics), and (c) improvement of fast timing system capabilities. The three preceding areas of improvement are discussed.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

55034 (UCRL—52000-77-4, pp 14-20) **Magnetic-quadrupole spectrometer: studying neutron reactions.** Haight, R.C. Apr 1977.

In Energy and technology review.

A magnetic-quadrupole spectrometer to measure the charged particles from nuclear reactions induced by 14-MeV neutrons was developed. A magnetic lens focuses the charged particles from the reaction site onto a distant detector. This protects the detector against neutron bombardment and greatly improves the signal-to-background ratio. This spectrometer is being used to assess potential radiation damage problems in fusion reactors of the future, to measure the energy deposited by neutron-induced reactions in biological systems, and to study the interaction between two neutrons. This same principle has been adapted to the measurement of fast charged particles from laser-induced fusion.

55035 Alpha-recoil spectrometer. McDaniel, P.J.; Hungerford, H.E. (Purdue Univ., West Lafayette, IN). *Trans. Am. Nucl. Soc.;* 26: 491(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55036 Some tests of the unfolding code COOLC. Kirmser, P.G. (Kansas State Univ., Manhattan); Hu, K.K.; Miller, W.H.; Meyer, W. *Trans. Am. Nucl. Soc.;* 26: 491-493(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55037 MATXUF: on-line, real time derivative method neutron spectrum unfolding. Miller, W.H. (Univ. of Missouri, Columbia). *Trans. Am. Nucl. Soc.;* 26: 493-494(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 55241

55038 (ORNL/TM—5769) **Uranium liquid-argon calorimeters: a calculational investigation.** Gabriel, T.A. (Oak Ridge National Lab., Tenn. (USA)). Jun 1977. Contract W-7405-ENG-26. 29p. Dep. NTIS, PC A03/MF A01.

A detailed calculational study has been performed to determine the response of uranium liquid-argon calorimeters to high energy (less than or equal to 20 GeV) incident protons. The results obtained are consistent with the recently published experimental data of Fabjan et al. This experimental data and the calculations indicate that "nuclear fluctuations", which limit the resolution of calorimeters containing ordinary materials, can be effectively reduced by the fissioning and capture characteristics of ^{238}U.

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

55039 (AD-A—038087) **Protective coaxial switching devices. Semi-annual technical report 15 Jun-14 Dec 76.** Levenson, L.M.; Philipp, H.R.; Slack, G.A. (General Electric Co., Schenectady, N.Y. (USA). Research and Development Center). Mar 1977. Contract DAAB07-76-C-1331. 52p. (SRD—77-047). NTIS, PC A04/MF A01.

The use and performance of NbO/NbO_2 chips supplied by ECOM in a coaxial switching device has been investigated. The material does exhibit switching with a delay time of less than 1 ns. The threshold switching voltage is typically 100 to 300 V. A manufacturable packaging configuration with evaporated small area contacts has been developed and fifty (50) completed devices have been supplied. Step by step details of all pertinent fabrication procedures, from selection of as received chips to final mounting and wire bonding of the completed unit are described. Device stability for a range of pulse lengths has also been investigated and is discussed in some detail. The electrical parameters of the as supplied chips do not however meet the specifications listed in the Technical Guidelines DAAB07-76-Q-1335 which require a threshold switching voltage <100. In addition, device degradation with repeated pulsing is observable even for 3 ns pulse widths and is markedly accelerated for larger pulse widths. (Author)

55040 (SAND—77-0171C) **Development of efficient, radiation-insensitive GaAs:Zn LEDs.** Barnes, C.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 4p. (CONF-770714—1). Dep. NTIS, PC A02/MF A01.

From IEEE conference on nuclear and space radiation effects; Williamsburg, Virginia, United States of America (USA) (12 Jul 1977).

A figure of merit for the radiation resistance of light-emitting diodes (LEDs) is the product of the pre-irradiation minority carrier lifetime, τ_{au_0}, and the damage constant, K. When the $\tau_{au_0}K$ product multiplied by the radiation fluence, PHI, gives a number comparable to 1.0, the LED will show significant degradation. Evidence in the literature suggests that $\tau_{au_0}K$ decreases with increasing p-type dopant concentration in the GaAs LEDs. This is further supported by measurements of diffusion length, L/sub n/, in GaAs as a function of dopant concentration. In Ge-doped p-type GaAs, L/sub n/ was constant with increasing Ge concentration, N/sub Ge/, up to N/sub Ge/ approximately 1×10^{18} cm^{-3}. However, above this concentration L/sub n/ was observed to decrease with increasing N/sub Ge/. This was attributed to a decrease in the radiative lifetime at large N/sub Ge/ concentrations. Below 10^{18} cm^{-3}, L/sub n/ was controlled by nonradiative centers, but above 10^{18} cm^{-3} the radiative lifetime decreased to the point where it determined L/sub n/ and hence, τ_{au_0}. The evidence outlined above suggests an attractive method for radiation hardening GaAs LEDs. By heavily doping the p side of the LED one obtains a small value of τ_{au_0} and hence a small $\tau_{au_0}K$. In addition, the radiative efficiency increases giving greater light output. This is to be contrasted with radiation hardening of many types of Si devices in which shortening of the lifetime to achieve radiation resistance results in poorer device performance. Similar problems are expected with ternary LEDs, such as GaAlAs, in which $\tau_{au_0}K$ is small but the radiative efficiencies are low. The device physics underlying this proposed hardening technique was studied by measuring light output, total current, and radiative decay time as a function of voltage before and after successive neutron irradiations. Results are presented and discussed. (WHK)

55041 (SAND—77-0371C) **Optimized photodetectors in radiation environments.** Mitchell, K.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 4p. (CONF-770714—2). Dep. NTIS, PC A02/MF A01.

From IEEE conference on nuclear and space radiation effects; Williamsburg, Virginia, United States of America (USA) (12 Jul 1977).

In an ionizing environment, the photodetector in an optoelectronic data link is a major source of unwanted signal. For a typical Si PIN photodiode, the signal induced by a 10^6 rad/sec dose rate is approximately 60 mA/cm^2, approximately 100 times the typical optical signal. The purpose of this study is to define the performance of various photodiode structures in ionizing radiation and to recommend optimized photodiodes for reliable digital communications in sustained ionizing environments. The response of Si and heterojunction photodiodes to light and to ionizing radiation are modeled for single-pass, two-pass, and multipass optical detectors.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 53677, 54001, 54079, 54373, 54483, 54517, 54556, 55136

55042 (BNL—22258) **New detector system for cathodoluminescence microscopy.** McKinney, W.R.; Hough, P.V.C. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 5p. (CONF-770333—2). Dep. NTIS, PC A02/MF A01.

From IITRI scanning electron microscopy symposium; Chicago, Illinois, United States of America (USA) (29 Mar 1977).

A new mirror is described which collects a significant fraction (approximately 70%) of the cathodoluminescent light emitted from a thin sample in the SEM. The mirror's small size (14 mm diameter) permits use of the microscope at its normal working distance. Its optical quality ellipsoidal surface focuses the light to a small spot outside of the chamber, in a narrow beam suitable for quantitative spectrophotometry. The dual display screens of the microscope (the AMR 1000B) are used for (1) fluorescence micrographs, with each bright dot in the picture generated by a detected photon; and (2) dark field STEM micrographs, with conversion from SEM accomplished by previously described passive conversion stub. (Scanning Electron Microscopy/1976, Part 1, p. 107-110). A liquid helium cold stage provides specimen temperatures down to 50°K and reduced contamination via a shield maintained at approximately 20°K. A fluorescence and TEM picture of a metaphase chromosome is presented, showing space resolutions for nucleic acid distributions of a few hundred angstroms or less.

55043 (BNL—22259) **Performance of standard SEM guns modified for convenient alignment and use of LaB_6 source.** McKinney, W.R.; Ledbetter, M.C. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 4p. (CONF-770333—3). Dep. NTIS, PC A02/MF A01.

From IITRI scanning electron microscopy symposium; Chicago, Illinois, United States of America (USA) (29 Mar 1977).

Simple modifications of the standard electron gun of the AMR 1000 SEM are described which facilitate the use of LaB_6 sources and provide for variation of Wehnelt aperture diameter. Modifications to the gun holder and anode permit the use of a Philips electron gun with a LaB_6 source in the AMR SEM. The Philips gun allows faster, more precise alignment of the source behind the smaller Wehnelt apertures necessary to realize the smallest source size of the LaB_6 source. The removable Wehnelt cap makes possible the cleaning of the aperture without complete disassembly. Filament lifetimes of several hundred hours are realized.

55044 (IS-M—90) **Design of the Broers type LaB_6 gun.** Verhoeven, J.D.; Gibson, E.D. (Ames Lab., Iowa (USA)). 1977. Contract W-7405-ENG-82. 7p. (CONF-770333—4). Dep. NTIS, PC A02/MF A01.

From IITRI scanning electron microscopy symposium; Chicago, Illinois, United States of America (USA) (29 Mar 1977).

An analysis is presented of the effect of the variables of the Broers type LaB_6 gun design upon the temperature distribution in the cathode. The analysis indicates that one may minimize power input and evaporation losses by utilizing short heater coils positioned as close as possible to the cathode tip. Experiments are reported on coils of 1 to 10 turn lengths which qualitatively confirm this analysis. A design is presented for a short coil arrangement (1 to 3.5 turns) which operates at a total power of 10 watts. It is found that successful operation of short coils requires a special grid shield.

55045 (K/TL—670) **Unique clamping techniques for strain gages.** Vornehm, R.G. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 13 May 1977. Contract W-7405-ENG-26. 9p. (CONF-770535—1). Dep. NTIS, PC A02/MF A01.

From Society for Experimental Stress Analysis meeting; Dallas, Texas, United States of America (USA) (15 May 1977).

Three examples of strain gage application problems and the methods used to solve the problems are presented. The examples are (1) apply gage on weld fillet to be tested at elevated temperature in uranium hexafluoride gas, (2) apply three full bridges (x-moment, y-moment, and torque) around a section of 48-in.-diameter pipe, and (3) apply gage on the inside of a small diameter pipe. (WHK)

55046 (SAND—77-0290C) **Force-frequency effect in doubly rotated quartz resonators.** Ballato, A.; EerNisse, E.P.; Lukaszek, T. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 4p. (CONF-770623—1). Dep. NTIS, PC A02/MF A01.

From Frequency control symposium; Atlantic City, New Jersey, United States of America (USA) (1 Jun 1977).

Precision frequency control requirements for digital communication and position location systems currently undergoing development make it imperative that crystal resonator performance be improved in a number of aspects. Accordingly, the potential of doubly rotated quartz cuts has begun to be explored (EerNisse, 1975, 1976; Ballato and Iafrate, 1976). For cuts on the upper zero temperature coefficient locus in general (theta approximately equal to +34°), and in the neighborhood of the SC-cut in particular (phi approximately equal to 21.9°, theta approximately equal to +33.9°), a variety of effects having their bases in nonlinear elasticity have been shown, or are predicted, to be reduced below the corresponding AT-cut values. In addition, the static frequency-temperature behavior shows some improvement. The force-frequency effect which has thus far not been investigated in any detail for doubly rotated quartz plate vibrators is studied. This effect relates the initial stress produced by the mounting supports to resonance frequency changes; it contributes to long-term aging and is also related to the frequency excursions produced by accelerations encountered in shock and vibration environments. Results are reported.

55047 (UCID—17484) **Fabrication procedure for the adiabatic surface thermometer.** Dittbenner, G.R.; Freynik, H.S. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Apr 1977. Contract W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

A special vacuum version of an adiabatic surface thermometer for automatically controlling a critical temperature-time cycle of a production vacuum-brazing process is described. This thermometer touches the surface and uses a differential thermocouple and heater to measure surface temperature without heat flow, thereby minimizing large errors caused by conduction losses common to conventional spring-loaded thermocouples. Some important advantages of our design for vacuum chamber use are: continuous operation at 850°C, intermittent operation to 1300°C, no outgassing or plating-off at high temperature in a vacuum system, and an integral connector that permits easy replacement of broken probes.

55048 (UCID—17503) **Instruction manual for a microwave ammonia monitor.** Hrubesh, L.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Jun 1977. Contract W-7405-ENG-48. 36p. Dep. NTIS, PC A03/MF A01.

The microwave ammonia monitor is a self contained (the vacuum pump is external) microwave rotational spectrometer that selectively detects and monitors ammonia vapor in air. A solid-state oscillator is used as the microwave source and a microwave cavity made from waveguide provides a chamber for the sample analysis. The air sample is continuously flowed through the waveguide cavity so that changes in the trace concentration of ammonia in air can be determined. The principle of operation of the microwave ammonia monitor is based on the absorption of microwave radiation by a vibration-rotation quantum transition of the ammonia molecule. Ammonia absorbs microwave radiation in a very narrow frequency range with its peak at 23,870.18 MHz. The microwave source is electronically controlled to oscillate only at this frequency and to provide a very stable output power. Thus, even a very small amount of microwave power that is absorbed by the ammonia gas is detectable and no other gas in the air sample is known to absorb any microwave radiation within the frequency output band of the oscillator. The specifications, operation, and maintenance procedures are described. Also a parts list and engineering drawings are included. (WHK)

55049 (UCID—17505) **Reflection efficiencies of x-ray mirrors 1-10 KeV.** Seward, F.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Jun 1977. Contract W-7405-ENG-48. 25p. Dep. NTIS, PC A02/MF A01.

Measured reflectivity curves are given for several x-ray mirrors. Energy and angle ranges covered are 0.9 to 15 keV and 0.5 to 2.0 degrees. Reflecting surfaces were Be, C, SiO_2, Ni, and Au. Measurements are complete for Ni and Au but only particular angles were measured for other mirrors.

55050 (UCRL—78737) **EPMT: a portable transfer standard for telemetry system pressure-transducer calibration.** Hasbrouck, R.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Apr 1977. Contract W-7405-ENG-48. 20p. (CONF-770418—2). Dep. NTIS, PC A02/MF A01.

From 9. transducer workshop of the Range Commanders Council; Fort Walton Beach, Florida, United States of America (USA) (26 Apr 1977).

The LLL developed electronic pressure meter (EPMT) is a portable static-pressure calibration instrument for use with the LLL telemetry transducer system at the Nevada Test Site (NTS). It is significantly more accurate and rugged than the bourdon-tube pressure gauge it replaces, and can be incorporated into a field-use, semi-automatic, pressure calibration system. The process by which a transducer is selected for EPMT use from the inventory of field-service-certified transducers and subjected to an extensive preconditioning and calibration procedure is described. By combining this unusual calibration procedure with a unique, statistically based data-reduction routine, the total uncertainty of the measuring process at each calibration point can be determined with high accuracy.

55051 (UCRL—79226) **Stress analysis and material certification for mechanically critical pressure transducers.** Burger, M.J.; Holten, D.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1977. Contract W-7405-ENG-48. 13p. (CONF-770418—1). Dep. NTIS, PC A02/MF A01.

From 9. transducer workshop of the Range Commanders Council; Fort Walton Beach, Florida, United States of America (USA) (26 Apr 1977).

The mechanical reliability of a pressure transducer becomes of paramount importance under certain use conditions, such as a high stress level, or a toxic, corrosive, or embrittling environment. In this type of application, the potential for total loss of a costly experiment through mechanical failure tends to override other considerations, such as linearity, zero shift, and temperature compensation. The application of stress analysis methods to pressure transducer design and of material certification to their manufacture are discussed. These two tools appreciably increase the transducer's mechanical reliability.

55052 **New optical multichannel microspectrofluorometer.** Jotz, M.M.; Gill, J.E.; Davis, D.T. (Univ. of California, Livermore). *J. Histochem. Cytochem.;* **24**: No. 1, 91-99(1976).

A new microspectrofluorometer has been developed that combines a photometric fluorescence microscope with an optical multichannel analyzer. This instrument provides fluorescence emission spectra of biological materials by detecting the entire spectrum simultaneously in real time. These spectra are subsequently recorded and corrected so as to identify the fluorescent reaction products or to test whether fluorescent cytochemical probes bind to the expected substrate within cells. The procedures and advantages of optical multichannel analysis are described, and an application of microspectrofluorometry to acriflavine-Feulgen cytochemistry is given. (31 references).

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 53723, 54000, 54004

55053 (UCRL—78875) **Range of investigation of a borehole gravimeter.** Hearst, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Feb 1977. Contract W-7405-ENG-48. 14p. (CONF-770626—1). Dep. NTIS, PC A02/MF A01.

From 18. annual symposium of the Society of Professional Well Log Analysts; Houston, Texas, United States of America (USA) (5 Jun 1977).

Concepts of the range of investigation of a borehole gravimeter are reviewed. It is shown that the maximum sensitivity to a mass point at a horizontal distance R from a borehole occurs at a vertical distance $Z = R/\sqrt{2}$. Thus, the angle of maximum sensitivity is about 55° from the vertical. It is also shown that the absolute value of the gravitational effect decreases with increasing R. There are two maxima of the vertical gradient of gravity (at $Z = 0$ and at $Z = \sqrt{3}/3$ R). The minimum distance required between gravimeter stations to obtain a usable measurement can be determined. The slab radius R for which the gravitational effect of a horizontal slab is equal to 45%, 90%, etc., of that of an infinite horizontal slab is a function of the measurement spacing. The closer the measurement spacing, the more information obtained.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

55054 (SAND—77-0416C) **New technique for determining the shock initiation sensitivity of explosives.** Schwarz, A.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 22p. (CONF-770635—1). Dep. NTIS, PC A02/MF A01.

From Conference on the standardization of safety and performance tests for energetic materials; Dover, New Jersey, United States of America (USA) (21 Jun 1977).

A new technique for determining the shock initiation sensitivity of explosives is described. It involves a flyer plate impinging upon the test explosive to induce initiation of detonation. An electrically exploded foil propels the flyer plate, which is a thin disk of polyimide (Kapton) 1 mm in dia; the charging voltage applied to the capacitor discharge fireset is used to preselect the desired velocity of the flyer plate. Its impact on the explosive introduces a rectangular pressure plus, P, whose amplitude depends on the velocity of the flyer at impact and the shock properties of the flyer and the explosive. The duration of the pulse, tau, depends upon flyer thickness. The test objective is to establish the critical pressure at a given duration which results in a 50 percent probability of detonating the explosive. The data, presented in a log P-log tau plot, generate a demarcation line between detonation and nondetonation regions. In the experiments the impact pressure was in the range of 1 to 10 GPa and the duration from 0.039 to 0.070 μs. Pentaery-thritol tetranitrate (PETN) and three forms of hexanitrostilbene (HNS) were evaluated. For both materials and variation of the threshold stimulus with initial compaction density was measured. Since a single flyer thickness was used in all but one of the experiments, the data for each explosive give only a single value (P, tau) on the demarcation line which separates detonation from nondetonation. Additional tests with other flyer thicknesses are needed to define this line over a broad range of tau. This new technique employs conventional laboratory equipment and a simple, inexpensive test device. The initiation stimulus may be expressed in a clearly defined form which is directly applicable to safety or performance computations.

NUCLEAR

REFER ALSO TO CITATION(S) 55050, 55093

55055 (AD-A—039063) **A low altitude meteorological data base. Topical report 13 Nov 75—12 Nov 76.** Gutsche, S.L.; Smith, K.S. (Mission Research Corp., Santa Barbara, Calif. (USA)). Aug 1976. Contract DNA001-76-C-0051. 352p. (MRC-N—255). .

A meteorological data base of the Northern Hemisphere for atmospheric pressure levels up to 50 mb (about 20 km) is described. The quantities provided are those which have proven to be useful in certain calculations of nuclear effects, such as modeling fireball rise and late time debris cloud movement. These quantities (provided at pressure levels of 850, 700, 500, 300, 200, 150, 100, and 50 mb) are: (1) mean easterly windspeed, (2) mean northerly windspeed, (3) vector standard deviation of windspeed, (4) temperature, (5) standard deviation of temperature, (6) dew point temperature, and (7) standard deviation of dew point temperature. The data is provided for all twelve months and seasons at five degree increments of latitude and longitude. How to access digital data appropriate for the four seasons and each month individually which is contained on magnetic computer tapes available through MRC or the DNA nuclear effects library, DASIAC, is described. In Appendix A, printed output from the data base for the seven quantities and eight pressure levels mentioned above is presented for the four seasons (output for each month would require more volumes).

WEAPONRY

55056 (AD-A—038738) **Combined airblast and incendiary effects from nuclear weapons on urban areas. Technical note.** Gould, K.E. (General Electric Co., Santa Barbara, Calif. (USA)). Aug 1975. Contract DNA001-75-C-0023. 60p. (DASIAC-TN—75-2). NTIS PCA04/MF A01.

The nuclear weapon airblast phenomena and free-field environment are described, vulnerability levels of buildings and building components to airblast are summarized, and damage zones are defined. The nuclear weapon thermal radiation phenomena are described and the free-field environment is estimated. A technique is described which permits the fraction of buildings burned up by initial ignitions and the local spread of fires to be illustrated as a function of weapon yield and distance from ground zero. Results from previous studies are used to apply the technique to single-family residential areas. The synergistic effects of airblast and thermal radiation and fires are analyzed and illustrated. It is concluded that for many conditions of interest (moderate height-of-burst, megaton weapon, reasonably clear atmospheric conditions and single-family residential areas), airblast may blow out initial fires so as to significantly reduce the fraction of houses burned up in areas suffering a relatively high degree of burnout; but areas of, for example, 25% to 40% burnout may be unaffected because they occur beyond the range at which airblast is assumed sufficient to extinguish fires.

55057 (USGS—474-179) **Geology of the Gold Meadows stock, Nevada Test Site.** Snyder, R.P. (Geological Survey, Denver, Colo.

(USA)). Jul 1977. Contract EY-76-C-04-0474. 28p. Dep. NTIS, PC A03/MF A01.

The Gold Meadows stock crops out in an elongate pattern about 1 mile (1.6 km) north of Rainier Mesa in the Nevada Test Site, Nevada. The long axis trends N. 35°E. Core and cuttings from three drill holes in the stock were analyzed chemically and petrographically. Modally the rock ranges from granodiorite to calc-alkaline granite, and three of five modes indicate that the rock is quartz monzonite. Chemically the rock differs from Nockolds' average quartz monzonite thusly: more SiO_2; slightly less than half total Fe; one-fourth MgO, same Na_2O and K_2O; Al_2O_3, CaO, and TiO range downward from slightly less than Nockolds' average to about one-half. The age of the stock has been determined by K/Ar dating to be 91.8 +- 2.6 m.y. Gravity data indicate the stock rose from southwest of the present outcrop. Flowbanding also indicates a source area to the southwest. Groundwater measurements from one deep drill hole indicate perched water at several places in the stock.

55058 (USGS—474-234) **Explosion-induced fractures of selected announced underground nuclear tests, Yucca Flat, Nevada Test Site, Nevada, January through December 1975.** Maldonado, F. (Geological Survey, Denver, Colo. (USA)). Jun 1977. Contract EY-76-C-04-0474. 110p. Dep. NTIS, PC A06/MF A01.

During the period Jan. through Dec. 1975, personnel of the U.S. Geological Survey mapped the surface effects produced by seven underground nuclear tests conducted in Areas 2, 3, 4, and 7, Yucca Flat, Nevada Test Site. Surface effects include such features as pressure ridges, fractures, and explosion-induced movements along previously mapped faults. Four tests yielded collapse sinks and mappable surface effects, two produced only sinks, and one test produced neither a collapse sink nor mappable surface effects.

55059 (USGS—474-237) **Analysis of the effect of orientation of a buried hemispherical excavation on the surrounding stress distribution.** Brethauer, G.E.; Magner, J.E. (Geological Survey, Denver, Colo. (USA)). Jul 1977. Contract EY-76-C-04-0474. 23p. Dep. NTIS, PC A02/MF A01.

An investigation of the stress around a buried hemispherical excavation, using finite-element methods, was undertaken to analyze and compare the effect of orientation relative to an assumed in situ stress field. Measured values for physical properties of the rock and for the assumed in situ stress were obtained from nearby locations. This analysis deals only with stress considerations and does not include geologic factors such as joints, joint frequency, and joint orientation. The most stable orientation of the hemispherical excavation is that in which the base is perpendicular to the direction of the minimum principal stress axis of the assumed in situ stress field. For this orientation the base strikes N. 15° E and dips 78° NW and the curved portion of the hemispherical excavation could be located on either side of the base.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

55060 (BNWL-SA—6085) **Pollutant transformation and removal measurements at Metromex.** Hales, J.M. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1977. Contract EY-76-C-06-1830. 29p. (CONF-770210—8). Dep. NTIS, PC A03/MF A01.

From A.A. advancement of science conference; Denver, Colorado, United States of America (USA) (20 Feb 1977).

Tracer studies of convective storm scavenging at METROMEX represent the most comprehensive effort to date in the field of multielement tracer applications for scavenging research. These began in the summer of 1971 with rather modest attempts to inject tracers into storm inflow regions from stacks and ground level positions, and developed into comparatively sophisticated, coordinated aircraft release schemes during subsequent years. While the surface-release experiments provided some indication of the efficiency of scavenging in specific cases, the aircraft experiments were much more valuable as indicators of the pertinent mechanisms of storm behavior. Some rather qualitative aspects of the tracer experiments, including experiment design and pertinent conclusions which have arisen from the studies, are discussed.

55061 **Aerosol growth studies. II. Preparation and growth measurements of monodisperse salt aerosols.** Tang, I.N.; Munkelwitz, H.R.; Davis, J.G. (Brookhaven National Lab., Upton, NY). *J. Aerosol Sci.;* **8**: 149-159(1977).

A continuous-flow apparatus has been developed for studying inorganic salt particle growth by water vapor condensation. Monodisperse salt aerosols in the submicron size range were prepared by nebulizing an aqueous solution, dried, and subsequently size separated using a mobility separator of simple construction. The aerosol extracted from the separator was subjected to various relative humidities, and the equilibrium size changes were measured with an optical counter calibrated for different particle shapes and refractive indices. The system was characterized by measuring the size changes exhibited by a NaCl aerosol at a number of specific relative humidities. The experimental results were compared with those calculated from thermodynamic considerations and good agreement was obtained. At 25°C, airborne NaCl particles were found to transform abruptly into saturated solution droplets at a relative humidity of 75.7 +- 0.4%. This is in good agreement with the reported value of 75.3% measured for the bulk solution. The technique is well suited for measuring the growth of either pure or mixed inorganic salt aerosols.

55062 **Treatment of advection in flux formulations for variable grid models, with application to two models of the atmosphere.** MacCracken, M.C.; Bornstein, R.D. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Comput. Phys.;* **23**: No. 2, 135-149(Feb 1977).

Numerical simulations using the flux form of the conservation equations on a nonuniform, staggered grid are shown to require careful consideration with respect to the selection of the advective velocities used to calculate the flux transport terms. Results from both a simplified form of an urban boundary layer model and from a complex global climate model demonstrate the appropriateness of the "flux-weighted" averaging technique which is presented in the paper as an alternative to linear averaging.

55063 **Statistical hypothesis tests of some micrometeorological observations.** SethuRaman, S.; Tichler, J. (Meteorology Group, Brookhaven National Laboratory, Upton N.Y. 11973). *J. Appl. Meteorol.;* **16**: No. 5, 455-461(May 1977).

Chi-square goodness-of-fit is used to test the hypothesis that the medium scale of turbulence in the atmospheric surface layer is normally distributed. Coefficients of skewness and excess are computed from the data. If the data are not normal, these coefficients are used in Edgeworth's asymptotic expansion of Gram-Charlier series to determine an altrnate probability density function. The observed data are then compared with the modified probability densities and the new chi-square values computed.Seventy percent of the data analyzed was either normal or approximatley normal. The coefficient of skewness g_1 has a good correlation with the chi-square values. Events with vertical-bar$g_1$vertical-bar<0.21 were normal to begin with and those with $0.21<$vertical-bar$g_1$vertical-bar<0.43 were approximately normal. Intermittency associated with the formation and breaking of internal gravity waves in surface-based inversions over water is thought to be the reason for the non-normality.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 53705, 53707, 54882, 54884, 55048, 55091, 55185, 55193

55064 (AD-A—038924) **Space power systems-what will be their impact on the upper atmosphere and ionosphere. Technical report.** Ching, B.K. (Aerospace Corp., El Segundo, Calif. (USA). Ivan A. Getting Labs.). 8 Apr 1977. Contracts F04701-76-C-0077;F04701-75-C-0076. 30p. NTIS PCA03/MF A01.

Space power systems are currently receiving widespread attention because of the significant contributions that they could make toward meeting our country's energy needs in the 21st century. Although the systems are environmentally 'clean' relative to alternative or complementary concepts, some effects may be produced in the earth's atmosphere and ionosphere that could ultimately have impact on other activities of our society and on the biosphere as a whole. Specifically, we must consider (1) interactions of the microwave radiation with the thermosphere and ionosphere, and (2) pollution of the entire atmosphere up through the thermosphere as a result of the high volume of space traffic that will be required to construct and then service and maintain the power satellites. Microwave propagation effects could result in ionospheric modification that would have adverse effects on communications systems. Pollution effects, particularly in the stratosphere, could lead to changes in the spectral properties of ultraviolet radiation at the earth's surface, which would alter a number of biospheric processes. These factors must be taken into account in the design and development of space power systems so as to minimize their impacts. In addition, since the pollution problem is not unique to power satellites alone, a careful assessment of this problem is necessary taking into account all advanced space systems concepts that require a high level of support by space transportation vehicles.

55065 (BNL—22283) **Mitigation of the effects of sulphur pollution.** Chang, B.; Wilson, R. (Harvard Univ., Cambridge, Mass.

(USA). Jefferson Physical Lab.). 5 Jul 1976. Contract EY-76-C-02-0016. 110p. Dep. NTIS, PC A06/MF A01.

As an introduction to the discussion of mitigation of the effects of SO_2, its health effect on man and the use of sulfates as indicators of the health hazard are first considered. The use of tall chimney stacks and intermittent control and other schemes to reduce the SO_2 release to the atmosphere are discussed. The problems of administration and forecasting are analyzed and legal problems associated with SO_2 control are reviewed. In an appendix an analysis of federal jurisdiction over interstate pollution and possible avenues of litigation open to the states is presented. (JSR)

55066 (EPRI-EA—323) **Survey of laboratory modeling of plume dynamics. Final report.** Riley, J.J.; Delisi, D.P. (Flow Research Co., Kent, Wash. (USA)). May 1977. 64p. Dep. NTIS, PC A04/MF A01.

The objectives of this study were to determine the overall capabilities of the laboratory modeling community to model the behavior of fossil-fuel power plant stack plumes and their impact on air quality, and to recommend whether and how these capabilities may affect a plume model evaluation program. An extensive literature survey of the laboratory studies of plume dispersion was conducted to meet these objectives. This report contains an overview of laboratory modeling, as well as a detailed description of the state-of-the-art of laboratory modeling. The major conclusion reached is that laboratory modeling can serve a useful role in verifying mathematical plume models; simulating the physical behavior of full-scale plumes, especially when structural effects, stratifications, and topography are important; and in combination with mathematical models, simulating the behavior of full-scale plumes. It is also concluded that field programs designed to verify mathematical models should also be designed with the additional consideration of verifying laboratory modeling.

55067 (LBL—5918) **Combustion-generated indoor air pollution.** Hollowell, C.D.; Budnitz, R.J.; Traynor, G.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1976. Contract W-7405-ENG-48. 17p. (CONF-770557—1). Dep. NTIS, PC A02/MF A01.

From 4. international clean air congress; Tokyo, Japan (16 May 1977).

It is obvious from this study that elevated levels of gaseous air pollutants (CO, NO, NO_2, and SO_2) and particulate sulfur and nitrogen compounds are present in indoor environments with gas cooking and heating appliances. High levels of CO and NO_2 approach or exceed promulgated and proposed ambient air quality standards. Such findings certainly indicate a potential impact of combustion-generated indoor air pollution on human health; and if borne out by further work, they may ultimately have a large impact on the future design of epidemiological studies, on energy conservation strategies for buildings, and on the need for more stringent control of air pollution from indoor combustion sources.

55068 (NTIS/PS—77/0360) **Atmospheric particle detectors (a bibliography with abstracts). Report for 1964-Apr 77.** Cavagnaro, D.M. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 160p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0219.

The cited reports cover detectors that are used primarily in air pollution and mine emission applications. Citations include monitoring site selection, applicable instrumentation, and determination of particle concentration. Excluded are studies on the chemical analysis of particles. (This updated bibliography contains 155 abstracts, 33 of which are new entries to the previous edition.)

55069 (PB—265376) **Environmental considerations study to accompany the westside industrial area development plan. Phase I in the city of Long Beach, California.** (Long Beach Economic Development Corp., Calif. (USA)). 1977. 112p. NTIS, PC A06/MF A01.

The primary environmental issues were determined to be air quality, energy conservation and noise. These issues occurred most frequently when examining the effects of potential changes to the redevelopment area.

55070 (PB—265735) **Colorado AQMA area source emission inventory. Final report.** (PEDCO-Environmental Specialists, Inc., Cincinnati, Ohio (USA)). Nov 1975. Contract EPA-68-02-1375. 130p. NTIS, PC A07/MF A01.

This report contains emission estimates for non point sources of air pollution in AQMA counties of the State of Colorado. Estimates for particulate, carbon monoxide, sulfur oxides, hydrocarbons and oxides of nitrogen emissions are made for the base year (present), 1980 and 1985. Methodologies and data sources are presented.

55071 (PB—265750) **Montana AQMA area source emission inventory. Final report.** (PEDCO-Environmental Specialists, Inc., Cincinnati, Ohio (USA)). Dec 1975. Contract EPA-68-02-1375. 168p. NTIS, PC A08/MF A01.

This report contains emission estimates for non point sources of air pollution in AOMA counties of the State of Montana. Estimates for particulate and sulfur oxide emissions are made for the base year (present), 1980 and 1985. Methodologies and data sources are presented.

55072 (PB—265767) **Network installation - the EPA Northern Great Plains ambient air monitoring network. Interim report.** (Northern Great Plains Resources Program, Denver, Colo. (USA)). 28 Dec 1974. 346p. (NGPRP/CD—74/104). NTIS, PC A15/MF A01.

Prepared by PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. Sponsored in part by Environmental Protection Agency, Denver, Colo. Region 8.

The ever-increasing demand for energy has focused the nation's attention on the coal deposits in the Northern Great Plains area which encompasses parts of the states of Montana, North Dakota, South Dakota, and Wyoming. Plans to develop these vast coal reserves are now being made. The importance of these coal deposits toward satisfying the nation's thirst for energy is obvious. It is equally important that activities associated with the mining and handling of coal not result in significant deterioration of the environment. The environmental impact of proposed developments must be carefully analyzed. In order to provide the basic data necessary to assess impacts upon future air quality, it is necessary to determine the current air quality of the affected area. The purpose of this report is to describe the installation phase and to give a comprehensive description of a network of 22 monitoring stations located throughout the region designated as the Northern Great Plains area.

55073 (PB—265806) **North Dakota AQMA area source emission inventory. Final report.** (PEDCO-Environmental Specialists, Inc., Cincinnati, Ohio (USA)). Nov 1975. Contract EPA-68-02-1375. 77p. NTIS, PC A05/MF A01.

This report contains emission estimates for non point sources of air pollution in AQMA counties of the State of North Dakota. Estimates for particulates, sulfur oxides, hydrocarbons and oxides of nitrogen emissions are made for the base year (present), 1980 and 1985. Methodologies and data sources are presented.

55074 (PB—266098) **Power plant stack plumes in complex terrain: an appraisal of current research. Interim report Nov 75—Oct 76.** Koch, R.C.; Biggs, W.G.; Hwang, P.H.; Leichter, I.; Pickering, K.E. (Geomet, Inc., Gaithersburg, Md. (USA)). Mar 1977. Contract EPA-68-02-2260. 235p. NTIS PCA11/MF A01.

This report reviews the literature of scientific studies of the behavior of stack plumes from fossil-fueled electric power plants in complex (hilly or mountainous) terrain. Non-conservative chemical transformation and depletion, and conservative transport and diffusion of pollutants are considered. Studies of SO_2 oxidation rates in power plant plumes are described and the primary mechanisms for conversion to sulfate are detailed. Scavenging of SO_2 from plumes by precipitation is reviewed along with surface contact and deposition as important plume depletion processes. Current theories of airflow, turbulence and diffusion phenomena in complex terrain are described, and are exemplified through the review of sixteen field observation programs of the physical behavior of plumes from continuous elevated sources in complex terrain. The review discusses program objectives, data sampling methodologies, model-to-measurement comparisons associated with the field program conclusions. The types of models available to simulate plume behavior numerically are discussed in the contexts of these programs. In addition, results are reported of an independent GEOMET analysis of delta(y) and delta(z) relationships in the Gaussian plume model over complex terrain, using data from LAPPES and TVA field measurement programs.

55075 (PB—266127) **Heterogeneous reactions of nitrogen oxides in simulated atmospheres. Interim report Nov 73—Nov 76.** Judeikis, H.S.; Siegel, S.; Stewart, T.B.; Hedpeth, H.R. (Aerospace Corp., Los Angeles, Calif. (USA)). Mar 1977. 34p. (ATR—75(7441)-2). NTIS PCA03/MF A01.

A laboratory study has been conducted on heterogeneous reactions of nitrogen dioxide and nitric oxide to evaluate their potential role in reaction in polluted urban atmosphere. The results of this study suggest that nitrogen dioxide decomposes on a wide variety of solids likely to be found in urban environments. Measured reaction rates indicate these processes can be important in the atmosphere. Humidification of reaction mixtures leads to increased reactivities. It is concluded that heterogeneous reactions in the atmosphere are unimportant for the oxidation of nitric oxide.

55076 (PB—266137) **Laboratory measurement of sulfur dioxide deposition velocities. Interim report Nov 73—Nov 76.** Judeikis, H.S.; Stewart, T.B. (Aerospace Corp., Los Angeles, Calif. (USA)). Mar 1977. 29p. NTIS PCA03/MF A01.

Measurements of sulfur dioxide deposition velocities have been carried out in the laboratory with the use of a cylindrical flow reaction. Analysis of data from these experiments was performed with models that specifically account for diffusive transport in the system. Consequently, the resulting deposition velocities were independent of diffusion processes and represented the maximum remov-

al rates that would be encountered in the environment under turbulent atmospheric conditions. The measured values ranged from 0.04 cm/sec for asphalt to 2.5 cm/sec for cement, and were independent of sulfur dioxide and oxygen concentrations as well as relative humidity and total pressure. Prolonged exposure to sulfur dioxide eventually destroyed the ability of the various solids to remove this species. Overall capacities increased significantly at moderate relative humidities, yielding values of 0.4 to 2.8 grams of sulfur dioxide per square meter of solid in moist systems. Several experiments indicated that the reactivity of a solid subjected to prolonged sulfur dioxide exposures could be restored by washing the surface with distilled water or exposing the spent solid to ammonia. Some implications of these findings relative to the environment are discussed.

55077 Studies on metal corrosion caused by air pollutants. II. Analysis of copper plate surface in atmospheres such as SO_2 and NOX by Auger electronic spectroscopy. Suzuki, S.; Matsumoto, K.; Sato, H. *Chiba Daigaku Kogakubu Kenkyu Hokoku;* No. 2, 59-68(1975). (In Japanese).

A copper plate (1 by 1 by 0.1 cm) was treated with concentrated nitric acid and the surfaces were thoroughly cleaned with distilled water. The plate was placed in a 100 ml tube reactor which was connected to a vacuum line. After drying at 0.005 torr for 0.1-1.0 hr, water was injected through a silicone rubber stopper. The water was evaporated and nitrogen dioxide or sulfur dioxide was introduced with a syringe. After exposure, the pressure was reduced to 0.0000001 torr and the Auger spectrum was recorded. Argon gas was then added to create a pressure of 0.000005 torr and the Auger spectrum was again recorded. Elements including oxygen, sulfur, nitrogen, silver, chlorine, and carbon were detected on the copper surface. Corrosion was detected before argon was introduced. Nitrogen and S disappeared after argon etching occurred.

55078 Trapping and chromatographic analysis of volatile organic pollutants in the atmosphere. Bourdin, M.; Badre, R.; Dumas, C. *Analusis;* 3: No. 1, 34-38(Jan 1975). (In French).

A method for the trapping and gas-chromatographic analysis of lightweight volatile hydrocarbons in the air is described. The sample to be analyzed is adsorbed in a Porapak Q-filled glass column, after which a condensing loop is cooled by liquid nitrogen to condense the hydrocarbons desorbed from the rest of the column heated at 100 C. With the condensation completed, the condensed hydrocarbons are heated to 140 C for injection to the chromatograph. Analytical experiments with an artificial mixture revealed high precision of the method even for low concentrations. This method is suitable for the analysis of volatile organic compounds in concentrations below 1 ppM.

55079 Comparison between in-stack and plume opacity measurements at oil-fired power plants. Conner, W.D. (Environmental Protection Agency, Research Triangle Park, NC). pp 478-483 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

The opacities of plumes emitted by oil-fired power plants are generally regulated by opacity emission standards and in many cases plants are required to monitor the opacity of their plumes and submit written reports of excess emissions. Because opacity monitoring measurements are normally made on the effluents in the stacks or ducts of plants, and opacity emission standards and the compliance test method apply to the opacity of the plumes emitted by the plants, the relationship between the in-stack and plume opacities of sources monitoring plume opacity is required if the monitor is to be used to show compliance with the standards. This study compares the in-stack and plume opacities of three oil-fired power plants of different sizes, operating at various loads and excess oxygen levels and burning fuels with different sulfur concentrations. The work was conducted as part of an overall study to characterize the particulate and gaseous emissions from oil-fired power plants.

55080 Examination of measurement methods for the characterization of gaseous sulfur emissions from combustion sources. Barnes, H.M.; Fortune, C.R.; Homolya, J.B.; Cheney, J.L. (Environmental Protection Agency, Research Triangle Park, NC). pp 484-489 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

In the past oil was considered a clean source of power. Compared to coal combustion there are about 90 percent less particulates from oil burning. Oil combustion does cause the emissions of many gaseous pollutants including NO/sub x/, SO/sub x/, CO, organic acids and partially burned hydrocarbons. The pollutants of interest in this program were sulfur oxides especially the ratio of SO_2 to SO_3 (measured as water soluble sulfate). Recent studies have shown that the sulfate emissions may be several times higher than suspected. Typically reported values of SO_2 to SO_3 conversion have been in the range 0.25 to 11.5 percent of the fuel sulfur with the most commonly cited range being 1.0 to 1.25 percent. However, data obtained from the North Carolina boiler leads one to conclude that as much as 10 percent and more typically 6 to 8 percent of the SO_2 can be converted to SO_3/SO_4. Sampling and analytical problems are discussed.

55081 Characterization of the gaseous sulfur emissions from coal and oil-fired boilers. Homolya, J.B.; Barnes, H.M.; Fortune, C.R. (Environmental Protection Agency, Research Triangle Park, NC). pp 490-494 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

A series of field sampling studies have been carried out to assess the atmospheric emissions of sulfate species from coal and oil-fired boilers. Emission sources were selected which would be representative of a cross-section of boiler designs with respect to size, operating characteristics, and fuel usage. Samples were collected and analyzed using modified EPA compliance test methods which, at present, provide a measurement of total sulfate emissions which includes SO_2, H_2SO_4, and inorganic sulfates. Results indicate a significantly higher level of sulfates in the flue gases of oil-fired sources as compared to coal-fired boilers. The extent of sulfate emission appears to be related to the metals content, particularly vanadium, of the fuels as well as the amount of excess air used for combustion.

55082 Physical characterization of particulate emissions from oil-fired power plants. Knapp, K.T.; Conner, W.D.; Bennett, R.L. (Environmental Protection Agency, Research Triangle Park, NC). pp 495-500 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

Studies conducted at several oil-fired power plants with different boiler design and burning different kinds of fuel have led to some interesting findings. The size distribution at those plants burning high V fuel was bimodal. The unit using domestic oil with low V was generally monomodal, with mostly particles less than 0.5 μm. The particulate mass loadings were about as expected. The units using the higher S fuel, which also contain a higher ash and more trace metals such as V and Ni, gave the higher particulate mass. Only in the case of the highest vanadium and sulfur content did excess boiler oxygen affect the particulate mass loading. No correlation between opacity and particulate mass was found.

55083 Chemical characterization of particulate emissions from oil-fired power plants. Bennett, R.L.; Knapp, K.T. (Environmental Protection Agency, Research Triangle Park, NC). pp 501-506 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

This investigation was made as part of an overall program on the physical and chemical characterization of particulate and gaseous emissions from oil-fired power plants operating at various loads and excess oxygen levels and consuming fuels of different sulfur and trace element composition. This paper is concerned primarily with the chemical composition of the particulate emission and the development of reliable characterization procedures.

55084 Application of an acid dewpoint meter for the measurement of sulfuric trioxide/sulfuric acid emission. Cheney, J.; Fortune, C.; Homolya, J.; Barnes, H.M. (Environmental Protection Agency, Research Triangle Park, NC). pp 507-511 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

Traditionally, the measurement of sulfur oxides in combustion sources has been conducted on an extractive basis. While numerous monitors for sulfur dioxide (SO_2) are now available, some of which do not require sample extraction, the higher oxides of sulfur, namely the trioxide (SO_3) and the acid (H_2SO_4) are still measured mostly by an extractive procedure. The two most commonly known methods for measuring SO_3/H_2SO_4 are the collection of the acid by absorption and by selectively condensing the acid in a temperature controlled condenser. Both of these methods, which involve the extraction and transport of the sample, have encountered considerable difficulties. The results can be summarized by stating that the accuracy is contingent on how well the separation can be achieved as well as how efficiently the acid can be collected. An alternate approach to measuring the acid content of a flue gas involves the

principle of relating the maximum temperature at which acid will condense on a temperature controlled surface to the acid concentration. The need of operating and maintenance personnel to obtain a quick estimation of the corrosive nature of a flue gas along with the previously mentioned problems of extractive sampling has created the appeal for the acid dewpoint approach. The preliminary work presented points out the need for a better understanding of flue gases and indicates that the methodologies used in flue gas sampling for the higher oxides need to be further evaluated. The formation and concentrations of the flue gas components are complex and due to their relationship to fuel, boiler design, operating conditions and other factors are difficult or impossible to predict. It is hoped that this work has elucidated some of the problems involved in such measurements, the need for continuing research for flue gas characterization methods, and the part that an acid dewpoint meter might contribute.

55085 Development of a source assessment sampling system. Harris, D.B.; Kuykendal, W.B.; Johnson, L.D. (Environmental Protection Agency, Research Triangle Park, NC). pp 549-556 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

This paper describes the philosophy, design, and testing of a Source Assessment Sampling System (SASS). The system was conceived as the primary sampling element in EPA's environmental assessment program. Basically, the SASS train is intended for use in any ducted source where a gas phase stream is to be subjected to a phased environmental assessment approach. The SASS train is designed to operate at 0.1 standard m^3/min (4 scfm) so that ample material will be obtained to characterize the emission potential of the stream. Elements in the SASS train separate the sample into size fractionated particulate, organic vapors, and inorganic components. Various analyses are performed to yield the particulate size distribution, organic and inorganic composition, and the biological activity of the sample components. Accuracy of the system is within a factor of two to three for screening purposes in the environment assessment phased approach.

55086 Use of multivariate analysis to identify sources of selected elements in the Boston urban aerosol. Hopke, P.K. (Univ. of Illinois, Urbana); Gladney, E.S.; Gordon, G.E.; Zoller, W.H.; Jones, A.G. *Atmos. Environ.;* **10**: 1015-1025(1976).

The concentrations of eighteen elements were determined by instrumental neutron activation analysis for samples of air particulates collected over a five month period in the Boston metropolitan area. This set of data is analyzed for underlying structure by the methods of common factor analysis and hierarchial aggregative cluster analysis. The data can be interpreted on the basis of six common factors accounting for 77.5% of the total variance in the system. These factors are attributed to various sources of particulate material by noting the dependence of the factors on the elements. The cluster analysis assists in the interpretation of the factors.

55087 Removal of cadmium ion from aqueous solution. Chou, E.J.; Okamoto, Y. (Polytechnic Inst. of New York, Brooklyn). *J. Water Pollut. Control Fed.;* **48**: No. 12, 2747-2753(Dec 1976).

The removal of trace amounts of cadmium ion from aqueous solution by foam separation using chelating surfactants was investigated. The chelating surfactants studied were dodecylbenzyltriethylenetetramine and 4-dodecyldiethylenetriamine. Cadmium ion was found to be removed almost quantitatively from aqueous solution using these surfactants and for the 4-dodecyldiethylene-triamine, the cadmium could be removed even in the presence of a large concentration of other metallic ions, such as Ca, Mg, and Na, at pH 7 to 9. Various factors affecting the removal of cadmium, such as pH, rate of gas flow, and surfactant concentration were investigated. The surfactant was regenerated and recycled by the decomposition of the surfactant-cadmium complex with Na_2S. Cadmium ion was precipitated as CdS and the regenerated surfactant was recycled.

55088 Lowering the cost of environmental protection. *PPI;* No. 1, 38-45(1977). (In German).

The 'classical' methods of waste air cleaning in surface engineering, chemistry and typography are thermal afterburning as a universal technique and catalytic afterburning under certain conditions. The third method, already in use for some time, is electric - or rather, electrically induced - afterburning. So far, there is only one producer in the FRG who has some experience with this system.

55089 Airborne measurements of pollutants over urban and rural sites. Alkezweeny, A.J.; Drewes, D.R. (Battelle-Pacific Northwest Laboratories, Richland, Wash. 99352). *J. Appl. Meteorol.;* **16**: No. 5, 561-563(May 1977).

Results of urban pollutant measurements made during an aircraft flight downwind of St. Louis are presented. Decreases in the levels of SO_2, NO/sub x/, and aerosol are noted, while O_3 is observed to increase to more than 200 ppb at 150 km downwind. The influence of a power plant plume is also observed.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

55090 (NVO—269-31) **Amchitka radiobiological program progress report, January 1976—December 1976.** Nelson, V.A.; Seymour, A.H. (Washington Univ., Seattle (USA). Lab. of Radiation Ecology). May 1977. Contract EY-76-S-08-0269. 56p. Dep. NTIS, PC A03/MF A01.

The Amchitka Radiobiological Program is a continuing program to collect biological and environmental samples for radiometric analyses. Results of analyses for samples collected during 1976 include gamma-emitting radionuclides in air filters, freshwater, birds, lichens, marine algae, marine invertebrates, fish, aufwuchs, and freshwater moss and plants; ^{90}Sr in rats, birds, and soil; $^{239,240}Pu$ in sand, soil, marine algae and fish; and tritium (^3H) in seawater, freshwater, and biological organisms.

55091 (ORO—3944-13) **Atmospheric tritium. Progress report, 1 April 1976—30 June 1977.** Ostlund, H.G. (Miami Univ., Fla. (USA)). 1977. Contract EY-76-S-05-3944. 67p. Dep. NTIS, PC A04/MF A01.

Data are reported from regular, twice or three times weekly, sampling of atmospheric HTO and HT at stations in Miami, FL; Mauna Loa, HI; Fairbanks, AK; and Baring Head, N.Z. In addition, sampling has begun in Miami also for tritium bound in lower hydrocarbons, here called CH_3T. In December 1974—January 1975, and again in January—February 1976, sampling was performed on board a ship en route from California to McMurdo (Antarctic). The data show a gentle, slight dilution of HT southwards from about 52 at/mg at 36°N to about 40 at/mg in New Zealand and south. During the period of this Data Report, the laboratory also participated in Project Airstream. Five series of stratospheric sampling flights were made, the programmed area of coverage of each was from 10°S latitude to 75°N latitude, and altitudes between 12 km and 19 km. The data are not included in this report, but will be published at an early date. In cooperation with the International Atomic Energy Agency (IAEA)/World Meteorological Organization Isotopes-in-Precipitation Network, monthly composite rain samples were measured for Miami, Barbados, and Western Samoa.

55092 (PB—265350) **Sampling and data reporting considerations for airborne particulate radioactivity. Final report.** Eadie, G.G.; Bernhardt, D.E. (Environmental Protection Agency, Las Vegas, Nev. (USA). Office of Radiation Programs). Dec 1976. 39p. (ORP/LV—76/9). NTIS, PC A03/MF A01.

This report discusses the evaluation of selected air filters for their suitability as collection media for the radiological analyses of airborne particulate matter. Standard four-inch diameter filters were analyzed for their natural radioactivity contents. Of the filters tested, glass fiber filters had the highest radium-226 content (0.35 picocuries per filter) and Microsorban filters contained roughly one-third of this activity. Microsorban filters also have lower uranium and thorium contents than do the glass fiber filters. For the analytical methods used in this study, all filter types tested had undetectable polonium-210, lead-210, and radium-228 contents. Dust loading characteristics of selected filters were also evaluated. The results indicate that Microsorban filters have higher collection and dust retention efficiencies (ranging from 6 to 26 percent greater) than do glass fiber filters. As a result of these evaluations, Microsorban filters are being used in the routine environmental radiological air quality monitoring networks operated by the Office of Radiation Programs - Las Vegas Facility (ORP-LVF).

55093 (UCRL—52000-77-4, pp 21-29) **Tracking the debris cloud from a Chinese nuclear test.** Peterson, K.R. Apr 1977.

In Energy and technology review.

As the radioactive debris cloud from a Chinese nuclear test on September 26, 1976 began drifting eastward, the Laboratory's computational facilities were pressed into service to predict the possible environmental effects. ERDA asked us to calculate cloud trajectories and to estimate the fallout dose. The FAA asked us to provide dose estimates both for commercial aircraft flights within the U.S. and for transatlantic flights of the Concorde SST. Our dose estimates, calculated with 2BPUFF, a large-cloud diffusion code, proved to be accurate predictions, correlating well with later observations. At FAA and ERDA request, we also worked with EG and G to measure cabin dose rates in some transatlantic SST and subsonic flights while the debris cloud moved out over the Atlantic Ocean.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

55094 (ANL/EMR—1(Vol.3a)) **Integrated mined-area reclamation and land use planning. Volume 3A. A case study of surface mining and reclamation planning: South Boulder Creek Park Project, Sand and Gravel Operations, Boulder, Colorado.** Lewis, L.R.; Perry, A.O.; LaFevers, J.R. (Argonne National Lab., Ill. (USA)). Feb 1977. Contract W-31-109-ENG-38. 96p. Dep. NTIS, PC A05/MF A01.

This case study details reclamation planning for the Flatiron Companies' South Boulder Creek Park Project in Boulder, Colorado. The site contains a deposit of high-quality sand and gravel considered to be one of the best and largest known deposits of aggregate materials in the Front Range area. The aggregate deposit is located in a highly visible site just off the Denver-Boulder Turnpike at the entrance to the city from Denver, and adjacent to a residential portion of the city. In order to make maximum use of premining planning, as a tool for resolving a conflict over the company's proposed operation, an extensive cooperative planning effort was initiated. This included the preparation of an environmental impact assessment, numerous public hearings, operating and reclamation plan review by city authorities, annexation of the site to the city, and the granting of a scenic easement on the property to the city for the development of a regional recreation park. A suite of contractual agreements was worked out among Flatiron Companies, the City of Boulder, the Colorado Open Lands Foundation, and the Federal Bureau of Outdoor Recreation. The purpose of this case study is to allow the planner to gain insight into the procedures, possibilities, and constraints involved in premining planning in a cooperative situation.

55095 Simulation of evapotranspiration and drainage from mature and clear-cut deciduous forests and young pine plantation. Swift, L.W. Jr. (Dept. of Agricultural Forest Service, Franklin, NC); Swank, W.T.; Mankin, J.B.; Luxmoore, R.J.; Goldstein, R.A. *Water Resour. Res.;* **11**: No. 5, 667-673(Oct 1975).

Prosper, a phenomenological model of water exchange between soil, plant, and atmosphere, was used to simulate evapotranspiration and annual drainage for 2 years from a mature oak-hickory forest in the southern Appalachians. The simulation was tested by comparing drainage to measured streamflow. In a year of unusually high precipitation the simulated annual drainage was within 1.5% of measured streamflow. Simulations were also performed by using the same 2 years of meteorologic data, but vegetation parameters were changed to represent a young white pine plantation and a regrowing hardwood forest 1 year after clear-cutting. The model estimated that drainage for an average rainfall year was reduced 20 cm by a 16-year-old white pine plantation and increased 36 cm by clear-cutting. These results were comparable to changes of -20 and +38 cm observed in watershed experiments at Coweeta Hydrologic Laboratory. Simulated evapotranspiration during the summer was nearly identical for hardwood and pine forests, while winter and early spring water loss was greater for pine. Simulation suggests that the greater evapotranspiration by pine was due to increased interception in all seasons and increased transpiration in the dormant season. For the clear-cut area, simulated evapotranspiration was considerably less than it was for the pine or hardwood forest and thus caused simulated soil moisture contents to be greater during the summer season.

55096 Moisture and solute transport in porous media. Wheeler, M.L. (Los Alamos Scientific Lab., NM). *ACS Symp. Ser.;* No. 35, 8-18(1976).

Natural earth materials, whether consolidated or unconsolidated, contain varying amounts of internal space not occupied by mineral material. This space is due to the presence of individual pores, and structural features such as joints and bedding planes. Generally, this internal space is interconnected, permitting the movement of water through the material and the associated transport of chemical species dissolved or suspended in the water. In some volcanic rocks, for example vesicular basalt, large portions of the pores are completely isolated from each other, with no opportunity for fluid movement between them; cementing agents, such as silicates or carbonates, may produce this same effect in granular materials. However, the bulk of the soil and rock material near the earth's surface contains interconnected pore spaces which allow the circulation of air or other gases and transport of water and associated materials. This paper discusses the interactions of porous geologic media with the water and solutes which effect the rate and direction of transport.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 53705, 54011, 55153

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 54156, 55090

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 53704, 53708, 53709, 54658, 55090

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 55104, 55111, 55145

55097 Two-dimensional numerical model for the simulation of partially mixed estuaries. Blumberg, A.F. (Johns Hopkins Univ., Baltimore). pp 323-331 of In Estuarine processes. Volume II. Circulation, sediments, and transfer of material in the estuary. Wiley, M. (ed.). New York; Academic Press (1977).

From 3. international estuarine conference; Galveston, Texas, United States of America (USA) (Oct 1975).

See CONF-7510111—P2.

A real time numerical model is developed to describe the longitudinal and vertical distributions of velocities and salinities as well as tidal amplitudes for partially mixed estuaries. One assumes the flow to be laterally homogeneous and uses realistic estuarine bathymetry. The external inputs to the model are the salinity and tidal amplitude as a function of time at the ocean boundary and the freshwater discharge at the river boundary. The model includes the continuity, salt and momentum balance equations, coupled by an equation of state. The elimination of the lateral momentum balance equation permits numerical solutions with little computing time. The numerical technique conserves salt, volume and momentum in the absence of dissipative effects. Simulations show the salinity intrusion to be highly sensitive to the vertical eddy viscosity, with minor changes to the tidal amplitude. Results from the application of the model using a stability dependent eddy viscosity and eddy diffusivity to the Potomac River yield distributions comparable to field observations.

55098 Simulation of estuarine circulations with a fully three-dimensional numerical model. Caponi, E.A. (Univ. of Maryland, College Park). pp 332-346 of In Estuarine processes. Volume II. Circulation, sediments, and transfer of material in the estuary. Wiley, M. (ed.). New York; Academic Press (1977).

From 3. international estuarine conference; Galveston, Texas, United States of America (USA) (Oct 1975).

See CONF-7510111—P2.

The Navier-Stokes, salinity and continuity equations in the Boussinesq approximation are spatially integrated on the elementary computational cells to provide equations for the temporal rate of change of the fluxes through every cell's face and of the mean salinity in every cell. The effect of the spatial subgrid scales is lumped together with the Reynolds stresses generated by the temporal discretization procedure, and modeled by a simple Fickian relationship. The pressure field in the momentum equations is split up into a hydrostatic and a dynamic parts, the latter obtained as the solution to a finite differences Poisson equation. The three momentum equations and the salinity equation are independently updated by a forward stepping scheme. The free surface is updated by a mass conserving scheme. Required boundary conditions are river inflows and surface elevation at the sea as a function of time, as well as applied winds and atmospheric pressure. The model has been implemented in a Fortran code. It admits arbitrary coastal boundaries, openings to the sea, river inflows and bathymetry, imposed by the user through data cards. Idealized test cases are used to show that the model behaves as physically expected. A coarse application to Chesapeake Bay shows qualitatively correct results and the need to incorporate a less naive representation for the sub-grid scales.

55099 Numerical formulation of a time dependent multi-level model of an estuary, with particular reference to boundary conditions. Hamilton, P. (Univ. of Washington, Seattle). pp 347-364 of In Estuarine processes. Volume II. Circulation, sediments, and transfer

of material in the estuary. Wiley, M. (ed.). New York; Academic Press (1977).

From 3. international estuarine conference; Galveston, Texas, United States of America (USA) (Oct 1975).

See CONF-7510111—P2.

A two dimensional model of the vertical circulation of an estuary has been developed, which solves, by an explicit finite difference initial value method, the equations of continuity, salt and momentum conservation for a channel of variable width and depth, but rectangular cross section. A further semi-implicit extension of the model is given, which removes the dependancy of the time step on the depth and makes feasible long integration periods. Features of the model include a finite difference grid which allows the tidally driven free surface to move vertically through the grid points, along with accurate finite difference formulations of the surface and bottom boundary conditions. If long periods of integration are considered, the effect on the salt balance of different formulations of the vertical eddy coefficients is shown to make the choice of the mouth boundary condition on salinity ambiguous.

55100 Formulation and closure of a model of tidal-mean circulation in a stratified estuary. Ward, G.H. Jr. (Espe, Huston and Associates, Inc., Austin, TX). pp 365-378 of In Estuarine processes. Volume II. Circulation, sediments, and transfer of material in the estuary. Wiley, M. (ed.). New York; Academic Press (1977).

From 3. international estuarine conference; Galveston, Texas, United States of America (USA) (Oct 1975).

See CONF-7510111—P2.

We consider the formulation of the lateral-mean tidal-mean momentum and salt balances in an estuary with rectilinear cross-section. Explicit treatment of the density current, typical of tidal-mean estuarine circulation, requires solution of the coupled equations of momentum and salinity. Central to this is the specification of the vertical eddy fluxes. Analysis of data from the Mersey and James estuaries indicates that the entirety of the vertical structure of the salt flux is determined by the local gravitational stability and the proximity to the vertical boundaries of the system, the absolute magnitude of the flux being established by the bulk hydrodynamic characteristics of the estuary. The structure of the momentum flux is further dependent upon the Richardson number ratio Rf/Ri, for which a functional form is suggested. An idealized analytical solution is given and numerical solution of the more general equations is discussed.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 53705, 54880, 54885, 54897, 55192, 55194

55101 (ORO—4939-4) **Development of biological indices for identifying and evaluating impacts of pollutants on freshwater ecosystems. Annual progress report, June 1, 1976—June 1, 1977.** Cairns, J. Jr.; Benfield, E.F.; Buikema, A.L. Jr.; Dickson, K.L.; Hendricks, A.C. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). 1977. Contract EY-76-S-05-4939. 188p. Dep. NTIS, PC A09/MF A01.

The overall objectives of this joint research effort were to devise and evaluate biological methods for determining the functional response of aquatic organisms to perturbations. Structural and functional aspects of autotrophic and heterotrophic attached microbial communities were studied in lotic systems with emphasis on carbon, nitrogen and sulfur. The uptake of carbon, nitrogen and sulfur under controlled and field situations was investigated along with biomass, ATP and chlorophyll measurement. Relationship of protozoan invasion and extinction rates to the eutrophication process were investigated. Protozoan invasion and extinction rates (utilizing artificial substrates) were measured under oligotrophic and eutrophic conditions in numerous lakes and reservoirs. Behavioral responses of zooplankton subjected to cooling water entrainment were examined. Zooplankton were subjected to various conditions that would be encountered during entrainment in order that the responses of the organisms might be ascertained. Detritus processing by macroinvertebrates was studied as a pollutional stress assessment technique.

55102 Remote sensing of coastal wetland vegetation and estuarine water properties. Klemas, V. (Univ. of Delaware, Newark). pp 381-403 of In Estuarine processes. Volume II. Circulation, sediments, and transfer of material in the estuary. Wiley, M. (ed.). New York; Academic Press (1977).

From 3. international estuarine conference; Galveston, Texas, United States of America (USA) (Oct 1975).

See CONF-7510111—P2.

The advantages and limitations of remote sensing techniques for collecting synoptic data over large coastal and estuarine areas are reviewed with emphasis on the need for a proper balance between remotely sensed data and ground truth. Specific applications include mapping wetland vegetation and coastal land use; monitoring natural and man-induced changes in the coastal zone; charting current circulation, including the movement and dispersion of known water pollutants; and determining the type and concentration of suspended matter in coastal waters. The photo-interpretation of aircraft and satellite imagery with the aid of ground truth is illustrated, employing both direct visual and automated computer techniques. For some applications, it is shown that an integrated boat-aircraft-satellite approach can produce better results or cost less, than the deployment of large numbers of boats or field teams without remote sensor support.

55103 Hydraulic model of Chesapeake Bay. McKay, J.H. Jr. (Army Corps of Engineers, Baltimore). pp 404-415 of In Estuarine processes. Volume II. Circulation, sediments, and transfer of material in the estuary. Wiley, M. (ed.). New York; Academic Press (1977).

From 3. international estuarine conference; Galveston, Texas, United States of America (USA) (Oct 1975).

See CONF-7510111—P2.

The Hydraulic Model of Chesapeake Bay is located at Matapeake, Maryland. It is a fixed bed geometrically distorted model constructed to a horizontal scale of 1 to 1000 and a vertical scale of 1 to 100, a distortion ratio of 10. The model will be operated using salt water introduced into the model ocean and fresh water flowing into the system through model tributaries. Linear geometric scales in conjunction with model laws determine hydraulic similitude between the model and its prototype. One year of hydrologic record in nature can be reproduced on the model in 3.65 days. The model will be used in the study of many different estuarine problems, including: the effects on salt water intrusion that are due to modifications of the physical or hydraulic regimen of the estuary; diffusion, dispersion, and flushing of wastes; the effects of power plant cooling water discharges; tidal flooding by storm surges. The Hydraulic Model of Chesapeake Bay will be a powerful addition to the tools available for analysis of estuarine physical problems by scientists, engineers, and planners working on Chesapeake Bay.

55104 Seasonal periodicity of diatoms, and silicon limitation in offshore Lake Michigan, 1975. Parker, J.I.; Conway, H.L.; Yaguchi, E.M. (Argonne National Lab., IL). *J. Fish. Res. Board Can.;* **34**: No. 4, 552-558(1977).

Diatom biomass maxima occurred in spring and fall and produced a bimodal bloom sequence at an offshore Lake Michigan station. The maximum in May was preceded by rapid growth as indicated by increased values of primary productivity and pigment concentration. As the spring bloom progressed, decreasing nutrient levels apparently slowed diatom growth. The diatom-biomass accumulation rate declined, assimilation quotients were minimal, and soluble reactive silicon was reduced from 13 to 6.8 μmol/l. In summer, after the bloom, diatom biomass and silicon reached seasonal minima of < 250 mg C/m^3 and approximately 1.0 μmol/l, respectively. Diatom biomass increased again in October when silicon supplies were replenished and the concentration exceeded 6.6 μmol/l. A critical silicon concentration of approximately 6.5 μmol/l may control the development and timing of offshore diatom populations in Lake Michigan.

55105 Dissolution of diatom frustules and recycling of amorphous silicon in Lake Michigan. Parker, J.I.; Conway, H.L.; Yaguchi, E.M. (Argonne National Lab., IL). *J. Fish. Res. Board Can.;* **34**: No. 4, 545-551(1977).

We measured the concentration of diatom frustules and amorphous silicon per gram of dry sediment at 5-m intervals in the upper water column (0 to 40 m), in sediment traps placed at 37 and 60 m below the surface, and in a sediment core. The average concentration of frustules per gram of dry suspended sediment in the water column was 3.14×10^8. The 37 and 60 m trap sample averages were 1.16×10^8 and 5.03×10^7 frustules/g dry sediment, respectively. Subsamples from the sediment core averaged 6.31×10^8 frustules/g dry surficial sediment. The average proportion of amorphous silicon/g dry sediment was 8.6% in the water column, 7.7% in the 37 m traps, 6.0% in the 60 m traps, and $<2.0\%$ in subsamples from the sediment core. The major fraction of amorphous silicon produced annually as diatom frustules was decomposed before incorporation in the permanent sediment. A comparison of the annual silicon requirement for diatom production and silicon inputs showed that the watershed contributes $<5.0\%$ of the dissolved reactive silicon required for annual diatom production. These observations suggest that recycling of biogenic silicon provides the major source of soluble reactive silicon required for diatom blooms in Lake Michigan.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 54007, 55090

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 54234, 55103, 55531

55106 (BNWL-SA—6222) **Avoidance of thermal effluent by juvenile chinook salmon (Oncorhynchus tshowytscha) and its implications in waste heat management.** Gray, R.H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Mar 1977. Contract EY-76-C-06-1830. 16p. (CONF-770516—8). Dep. NTIS, PC A02/MF A01.

From Conference on waste heat management and utilization; Miami Beach, Florida, United States of America (USA) (9 May 1977).

Knowledge of behavioral responses of aquatic organisms to thermal discharges at power plants is essential to evaluate thermal exposure and subsequent effects on survival and ecological success. Instantaneous responses of juvenile salmon that encountered a simulated river-thermal plume interface were assessed in a model raceway with a thermal discharge. Fish movement and response to the discharge were recorded on videotape. Juvenile chinook salmon (Oncorhynchus tshawytscha) tested under three discharge conditions (no plume, ambient plume and heated plume) avoided plume temperatures greater than 9 to 11°C above ambient. Fish occasionally oriented to the discharge current, but were not attracted to the thermal component of the plume when plume ΔT's were below the avoidance level of 11°C. Fish did not pass to the lower end of the raceway when plume ΔT exceeded 9 to 11°C. The responses noted in our experiments suggest organismic behavior may prevent juvenile salmon in nature from experiencing lethal conditions from thermal discharges and have application in waste heat management and utilization.

55107 (IIHR—167) **Investigation of surface-jet thermal outfall for Iatan Steam Electric Generating Station.** Sayre, W.W. (Iowa Inst. of Hydraulic Research, Iowa City (USA)). Apr 1975. 65p. State Univ., Iowa City, IA.

The feasibility of a surface-jet thermal outfall for discharging the condenser cooling water from the proposed Iatan Steam Electric Generating Station near Iatan, Missouri into the Missouri River is investigated. Hydrographic measurements by the U.S. Geological Survey show that the geometry of and distribution of flow in the river channel is favorable for a surface-jet scheme. Downstream temperature-rise distributions are predicted for surface jets discharging both at right angles and parallel to the ambient flow for selected river discharges. The prediction technique takes into account the properties of the ambient flow, including the mixing mechanisms, as well as those of the jet. The right-angle discharge is predicted to be superior in almost every respect. For one-unit operation at full plant load and a river discharge of 10,000 cfs, it is predicted that the 5°F temperature-rise isotherm would cover a horizontal area of less than 0.5 acres and the zone-of-passage wherein the temperature rise in less than 5°F exceeds 85 percent of the river flow.

55108 (IIHR—182) **Thermal regimes of the upper Mississippi and Missouri Rivers. Part one: transient and steady-state computational models for the prediction of river thermal regimes. Part two: analysis of thermal regimes of the Mississippi and Missouri Rivers in the Mid-Continent Area Power Pool (MAPP) geographical area.** Paily, P.; Su, T.Y.; Giaquinta, A.R.; Kennedy, J.F. (Iowa Inst. of Hydraulic Research, Iowa City (USA)). Oct 1976. 407p. of Iowa, Iowa City, IA.

A computer-based, numerical model for calculation of streamwise distributions of temperature in rivers was developed, validated, and utilized to calculate the thermal regimes of the reaches of the Mississippi and Missouri Rivers lying within the MAPP geographical area. The salient features of the computational model are described and compared with three transient models. The thermal regimes of the Mississippi and Missouri Rivers in the MAPP geographical area corresponding to average meteorological and hydrological conditions for the months of February, May, August, and November were determined by means of the steady-state ITRM; the results are presented and discussed. The natural thermal regimes of the rivers and the modified thermal regimes resulting from imposition of external heat loads from nuclear and fossil-fuel power plants and other heat sources were calculated. The locations along the rivers at which new plants of reasonably large size could be installed in accordance with the existing thermal standards were identified. The capacities of these plants were determined on the basis of the calculated temperature distributions with the thermal loads of the existing, proposed, and projected once-through plants imposed on the rivers.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 53634, 54693

REGULATIONS

REFER ALSO TO CITATION(S) 54693

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 54665

55109 **Resource systems analysis.** Veigele, W.J.; Clayson, R.L. pp 512-517 of In Energy and the environment. Theodore, L. (ed.). Dayton, OH; American Institute of Chemical Engineers (1976).

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976). See CONF-761016—.

We are convinced that it is necessary and practical to examine the interrelated aspects of resource problems. The methodology described becomes more complicated in situations in which many variables prove to be significant. Also, for many urban areas or planning regions the simulation models need to be more sophisticated than those used successfully in relatively small and isolated urban areas, such as the area with which this study was concerned. However, the solution of these problems appears to be far less costly than the corrective measures likely to be necessary if we continue to ignore the possibilities of, and the need for objective resource systems analyses. Science, aystems analysis, computer analysis and simulation, economics, and organizational behavior are disciplines which we believe must be integrated into a useful resource systems analysis.

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 53645, 53716, 53977, 54239, 54653, 54654, 54656, 54659, 54664, 54692, 54700, 55094

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 53743, 54657, 54659

55110 (BNL—22363) **Criteria for risk acceptance: a health physicist's view.** Hull, A.P. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 4p. (CONF-770409—8). Dep. NTIS, PC A02/MF A01.

From 4. congress of the International Radiation Protection Agency; Paris, France (24 Apr 1977).

A controversy over the safety of nuclear energy has grown in the U.S. since about 1970 and has now spread to near worldwide proportions. This controversy has been fueled by a variety of issues. Initially in the U.S. the most prominent issue concerned the degree of hazard of low-level radiation, in particular that associated with the nuclear fuel cycle. Since then, attention has shifted successively to the reliability of emergency core cooling systems, the longevity of nuclear wastes, the possible misuse of radioactivity by terrorists and the potential for diversion of nuclear-power-produced plutonium to weapons fabrication. Underlying each of these issues has been the implication that the employment of nuclear power will entail an unacceptable risk to the public. A reasonable perspective in this regard is a yearly risk of 1×10^{-6} compared to the level of natural hazards such as earthquakes, floods, hurricanes, and tornados. Following a satisfactory demonstration of the safety of nuclear energy, hopefully the nuclear argument could be terminated. Society could then move on to the real issues affecting energy, population and quality of life.

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 54235

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

55111 Evaluation and use of gear efficiencies in the estimation of estuarine fish abundance. Kjelson, M.; Colby, D.R. (Atlantic Estuarine Fisheries Center, Beaufort, NC). pp 416-424 of In Estuarine processes. Volume II. Circulation, sediments, and transfer of material in the estuary. Wiley, M. (ed.). New York; Academic Press (1977).

From 3. international estuarine conference; Galveston, Texas, United States of America (USA) (Oct 1975).

See CONF-7510111—P2.

Accurate estimates of fish abundance are necessary for models of many estuarine processes, but they have generally been unavailable because fish sampling methods are biased. A major source of bias is a fish's avoidance of sampling gear. A brief discussion of theoretical and qualitative information concerning net avoidance and a simple gear efficiency model is presented. Results of quantitative studies on the efficiency of sampling gear have potential for correcting bias due to net avoidance. Discussion of gear efficiency studies for a plankton net, beam trawls, portable drop-net, haul seines and otter trawls are provided and indicate that such research is feasible and can yield useful information. Our ongoing investigation on the efficiency of a 6.1 m otter trawl for Lagodon rhomboides and Leiostomus xanthurus in a North Carolina estuary during 1975 indicates that trawl abundance estimates for these species were only 9 to 51% of the true values. General recommendations are given to assist in limiting the problem of fish sampling bias.

55112 Mus musculus and Peromyscus maniculatus: homing ability in relation to habitat utilization. Anderson, P.K.; Heinsohn, G.E.; Whitney, P.H.; Huang, J.P. (Univ. of Calgary, Alberta). *Can. J. Zool.;* **55**: No. 1, 169-182(Jan 1977).

House mice displaced from established home ranges in grassland on Great Gull Island, New York, exhibited homing behavior. This behavior was associated with large home range, wandering before home range establishment, and forays outside the range. When both house mice and deer mice inhabiting granaries in grassland in Alberta were displaced, homing behavior was poorly expressed in house mice, but well developed in deer mice. The poorly developed homing tendency of Alberta house mice was associated with a pattern of habitat utilization that appeared to limit familiarity with areas outside the home range. While this result does not explicitly eliminate a role for a direction-finding ability in house mouse homing, it does emphasize the importance of familiarity with terrain external to the home range.

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 54921, 55168, 55177, 55182, 55190

55113 (LBL—6442) **Role of hypermodified bases in transfer RNA-solution properties of dinucleoside monophosphates.** Watts, M.T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1977. Contract W-7405-ENG-48. 211p. Dep. NTIS, PC A10/MF A01.

Thesis.

The hypermodified dinucleoside monophosphates, uridylyl(3′-5′)N-[9(β-D-ribofuranosyl)-purin-6-ylcarbamoyl]threonine (Upt^6A), adenylyl(3′-5′)N^6-(Δ^2-isopentenyl)adenosine (Api^6A), adenylyl(3′-5′)N^6-(Δ^2-isopentenyl)-2-methylthio-adenosine ($Apms^2i^6A$), and adenylyl(3′-5′)1-N^6-ethenoadenosine (Ap epsilon A, a synthetic model for adenylyl(3′-5′)wybutosine, ApyW), which represent the most common sequences found as the third letter of the anticodon triplet and its adjacent 3′-neighbor, have been isolated. Upt^6A was purified after an enzymatic degradation of yeast tRNA, and Api^6A, $Apms^2i^6A$, and Ap epsilon A were isolated subsequent to their chemical syntheses from their component nucleosides. Their solution properties have been investigated using UV absorption, circular dichroism (CD), and high resolution proton magnetic resonance. The properties of these molecules have been compared to those of their unmodified counterparts, uridylyl-(3′-5′)adenosine (UpA) and adenylyl(3′-5′)adenosine (ApA), in order to learn of the function(s) of the hypermodified bases in transfer RNA. The properties measured as a function of temperature have been analyzed employing a two-state intramolecular stacking model. The results from all of the techniques used indicate that hypermodification of the unmodified dinucleoside phosphates changes their stacking abilities. Static measurements of the properties suggest that the stacking differences are caused by conformational changes induced by the hypermodifications of the A residue.

55114 Decarboxylation of oxalacetate to pyruvate by purified avian liver phosphoenolpyruvate carboxykinase. Noce, P.S.; Utter, M.F. (Case Western Reserve Univ., Cleveland). *J. Biol. Chem.;* **250**: No. 23, 9099-9105(1975).

Phosphoenolpyruvate carboxykinase, which has been isolated from chicken liver mitochondria in essentially homogenous form, carries out the irreversible decarboxylation of oxalacetate to pyruvate in the presence of catalytic amounts of GDP or IDP, as well as the reversible decarboxylation of oxalacetate to phosphoenolpyruvate in the presence of substrate amounts of GTP or ITP. The pyruvate- and phosphoenolpyruvate-forming reactions are similar in their nucleoside specificity and appear to be carried out by the same protein. However, the two activities vary markedly in their response to added metal ions and sulfhydryl reagents. Phosphoenolpyruvate formation is completely dependent on the presence of a divalent metal ion, with Mn^{2+} the most effective species. This reaction is also stimulated by sulfhydryl reagents such as 2-mercaptoethanol. In contrast, the pyruvate-forming reaction is strongly inhibited by divalent metal ions, including Mn^{2+}, and also by moderate concentrations of sulfhydryl reagents. These observations and the demonstration that pyruvate kinase-like activity is very low or absent make it unlikely that pyruvate formation proceeds via phosphoenolpyruvate as an intermediate. Although the pyruvate-forming reaction is inhibited by added metal ions, the reaction is also inhibited by metal-chelating agents such as 8-hydroxyquinoline and o-phenanthroline, suggesting that the reaction is dependent on the presence of a metal ion. It has not been possible, however, to demonstrate that the enzyme is a metalloprotein.

55115 Carbon-13 nuclear magnetic resonance spectroscopy of suspensions of Chinese hamster ovary cells specifically enriched with [methyl-^{13}C]choline. London, R.E.; Hildebrand, C.E.; Olson, E.S.; Matwiyoff, N.A. (Los Alamos Scientific Lab., NM). *Biochemistry;* **15**: No. 25, 5480-5486(1976).

The mammalian Chinese hamster ovary cell line (CHO) was labeled with [methyl-^{13}C]choline. Under the conditions used, approximately 42% of the cellular choline was found to be associated with cellular lipids and the remaining 58% was present in the water-soluble fraction of the cell, primarily as phosphorylcholine. The spin-lattice relaxation time (T_1) of this pool of phosphorylcholine indicates an intracellular viscosity approximately 1.2 times that of H_2O. Cells fixed with formaldehyde and washed several times did not exhibit ^{13}C resonances corresponding to free choline or phosphorylcholine and were sufficiently stable to be studied up to 43°C. The T_1 and line width behavior of the methyl resonance was studied as function of temperature in the fixed cells. The T_1 data exhibited an Arrhenius dependence with an activation energy of 4.3 kcal/mol, similar to that observed for free choline. The line width does not conform to an Arrhenius law and the values obtained for the CHO cells are similar to those previously reported for sonicated lecithin vesicles and to the value obtained in sonicated lecithin vesicles prepared from the extracted CHO cell lipids. The values are significantly smaller than the values reported for unsonicated lecithin dispersions. The data are discussed in terms of a theoretical model involving multiple internal rotations. A measurement of the ^{13}C-^{1}H nuclear Overhauser enhancement for the choline methyl carbons in vesicles prepared from the extracted CHO cell lipids gave a value of 3.0 +- 0.3.

55116 Lipid storage and utilization in reptiles. Derickson, W.K. (Argonne National Lab., IL). *Am. Zool.;* **16**: No. 4, 711-723(Fal 1976).

Lipids represent a biochemically efficient mechanism for storing energy to be used at a later date for maintenance and/or reproduction. This storage and utilization at different times results in seasonal patterns of lipid cycling. Reptiles exhibit a number of lipid cycling patterns which can be explained by seasonal patterns of food availability. Seasonality in food availability determines the quantity of lipids stored, when lipids are stored, and for what purposes these lipids are utilized. Lipid cycling patterns are in turn correlated with life histories.

55117 Primary structure of the human pancreatic secretory trypsin inhibitor. Bartelt, D.C.; Shapanka, R.; Greene, L.J. (Brookhaven National Lab., Upton, NY). *Arch. Biochem. Biophys.;* **179**: 189-199(1977).

The amino acid sequence of human pancreatic secretory trypsin inhibitor [Pubols, M. H., Bartelt, D. C., and Greene, L. J. (1974) J. Biol. Chem., 249, 2235-2242] was determined by a combination of selective trypsin and chymotrypsin hydrolysis reactions on the S-2-aminoethylcysteinyl inhibitor and conventional methods (subtractive Edman degradation and expopeptidase hydrolysis) for sequence determination of small peptides. The peptides were ordered on the basis of the identification of the amino- and carboxy-terminal residues of the products at each stage of the degradation procedure. The sequence determination was carried out on a mixture of chromatographic forms present in both tissue and pancreatic juice which are identical in amino acid composition, amino-terminal residues, molecular weight, and specific activity, but differ only in asparagine

content and susceptibility to enzymatic hydrolysis. The amino acid sequence of the human inhibitor corresponding to chromatographic form A_3 has been shown to the NH_2-Asp-Ser-Leu-Gly-Arg-Glu-Ala-Lys-Cys-Tyr-Asn-Glu-Leu-Asn-Gly-Cys-Thr-Lys-Ile-Tyr-Asn-Pro-Val-Cys-Gly-Thr-Asp-Gly-Asp-Thr-Tyr-Pro-Asn-Glu-Cys-Val-Leu-Cys-Phe-Glu-Asn-Arg-Lys-Arg-Gln-Thr-Ser-Ile-Leu-Ile-Gln-Lys-Ser-Gly-Pro-Cys-COOH. The structure is compared with homologous inhibitors from porcine, bovine, and ovine pancreas.

55118 Amino acid composition of casein isolated from the milks of different species. Lauer, B.H.; Baker, B.E. (McGill Univ., Montreal). *Can. J. Zool.;* **55**: No. 1, 231-235(Jan 1977).

Casein was isolated from the milks of the following species: cow, horse, pig, reindeer, caribou, moose, harp seal, musk-ox, polar bear, dall sheep, and fin whale. The caseins were subjected to acid hydrolysis, the resultant amino acids were converted to their n-butyl-N-trifluoroacetyl esters, and the amino acid composition of the caseins was determined by gas chromatographic analysis of these esters. Notable among the results was the close similarity, with respect to amino acid composition, of reindeer and caribou caseins. The results of the amino acid analyses of the other caseins are presented and discussed.

55119 Enzymes as reagents in peptide synthesis: enzyme-labile protection for carboxyl groups. Glass, J.; Pelzig, M. (City Univ. of New York). *Proc. Natl. Acad. Sci. U.S.A.;* **74**: No. 7, 2739-2741(Jul 1977).

N-Benzyloxycarbonyl derivatives of isoglutamine and isoasparagine were coupled with arginine methyl ester through the action of dicyclohexylcarbodiimide. The resulting benzyloxycarbonyl derivatives of isoglutaminylarginine methyl ester and isoasparaginylarginine methyl ester were treated with trypsin for removal of the ester groups and then with porcine pancreatic carboxypeptidase B for liberation of arginine and the original benzyloxycarbonyl derivatives of isoglutamine and isoasparagine. This scheme represents a reversible masking of the side-chain carboxyl functions of aspartic and glutamic acid residues. Possible applications of esters and amides of arginine as reversible blocking groups in protein semi-synthesis are discussed along with prospects and strategies for developing related techniques of higher efficiency.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 54943

55120 Transfer of methyl groups from N-dimethylnitrosamine to glycerolipids in rat liver. Snyder, F.; Malone, B. (Oak Ridge Associated Universities, TN). *Chem.-Biol. Interact.;* **13**: No. 3/4, 237-241(Jun 1976).

The in vivo labeling of lipids was examined after a single intraperitoneal injection of the carcinogen, [^{14}C] dimethylnitrosamine, into rats. Liver was most active in incorporating [^{14}C] methyl groups into lipids (0.91 percent of the injected dose) and 80 percent of the activity appeared in sn-3-phosphatidylcholine. Chromatographic analysis of the products (and derivatives) formed after treatment of the [^{14}C] phosphatidylcholine with phospholipase A_2 (EC 3.1.1.4) and phospholipase C (EC 3.1.4.3) demonstrated that 89 percent of the radioactivity was in the choline moiety. These results indicate the transfer of methyl groups to lipids occurred via the lipid methylation pathway that converts phosphatidylethanolamine to phosphatidylcholine.

CYTOLOGY

REFER ALSO TO CITATION(S) 55144

55121 Cellular interactions controlling the immune reactivity of T-lymphocytes. Cohen, I.R.; Feldman, M. (Weizmann Inst. of Science, Rehovot, Israel). *Ann. N.Y. Acad. Sci.;* **249**: 106-115(28 Feb 1975).

The sequence of developmental processes of thymus-derived lymphocytes can be classified into two distinct stages. The first stage constitutes the appearance of lymphocytes in the thymus capable of recognizing antigenic signals. Such lymphocytes leave the thymus and colonize the spleen and lymph nodes. The second stage involves the response of thymocytes to antigenic signals. When a given cell-bound antigen triggers thymocytes capable of recognizing the antigen killer cells develop capable of lysing target cells possessing the same surface antigens that triggered their development. Studies indicated that both these stages are regulated by cell interactions. Results of the following studies are reported: in vitro induction of T-cell properties by thymus reticulum cells; interactions between thymocytes and the differentiation of effector cells; and control of the differentiation of effector lymphocytes by suppressor T-cells. (HLW)

55122 'Cleavage' and cortical granule breakdown in Rana pipiens oocytes induced by direct microinjection of calcium. Hollinger, T.G.; Schuetz, A.W. (Oak Ridge National Lab., TN). *J. Cell Biol.;* **71**: 395-401(1976).

Microinjection of ~0.3 μg of calcium into maturing oocytes of Rana pipiens after nuclear dissolution resulted in cleavage-like constrictions, cortical granule breakdown, and formation of a structure resembling a two-cell embryo. Mg^{2+}, Na^+, or K^+ did not induce any of these reactions. Larger amounts of Ca^{2+}-induced contraction over the entire surface of oocytes or eggs, but did not induce cleavage-like constrictions; smaller amounts of Ca^{2+} produced either a local cortical granule reaction or the formation of one large and one small "blastomere." Furrow formation was not observed during normally induced maturation until after geminal vesicle breakdown. The location of microinjected Ca^{2+} determined the orientation of the resulting furrow. Ca^{2+}-induced cortical granule breakdown occurred in full-grown nonmaturing oocytes near the site of injection. Cortical granule breakdown also occurred in maturing oocytes (after germinal vesicle breakdown but before second meiotic metaphase), but only in the blastomere containing the injected Ca^{2+}. As expected, in mature oocytes (at second meiotic metaphase) cortical granule breakdown occurred over the entire oocyte surface, including both blastomeres. The results indicate that furrow formation and cleavage like constrictions may e directly influenced by Ca^{2+}, and that functional contractile elements are present near all areas of the oocyte surface. Furthermore, Ca^{2+} injection initiates localized cortical granule breakdown in full-grown immature and maturing oocytes.

GENETICS

55123 Practical evaluation of mutagenicity data in mammals for estimating human risk. Brewen, J.G. (Oak Ridge National Lab., TN). *Mutat. Res.;* **41**: 15-24(1976).

Chromosomal aberrations are known to constitute a significant portion of the genetic risk from practically all mutagenic agents. These effects are diverse in both nature and in the stage of the germ cells' life cycle at which they are produced. Arguments are made pointing out many of the problem areas in our understanding the significance of chromosomal aberrations in relation to genetic risk. Data are summarized that offer explanations as to why so few chromosomal effects are recovered after treating spermatogonial stem cells, how chromosome damage and dominant lethality are correlated when postmeiotic germ-cell stages are treated with MMS, and why so few reciprocal translocations are recovered after irradiation of oocytes.

55124 Ethidium bromide induced cytoplasmic male sterility in pearl millet. Burton, G.W.; Hanna, W.W. (Univ. of Georgia, Tifton). *Crop Sci.;* **16**: No. 5, 731-732(1976).

Seeds of homozygous "Tift 23DB$_1$" pearl millet [Pennisetum americanum (L.) K. Schum], maintainer for cytoplasmic male sterile (cms) "Tift 23DA$_1$," were soaked in deionized water solutions of 250 and 1000 ppM of ethidium bromide (EB) at 5°C for 40 hours. Treated seeds were rinsed in tap water for 30 min, surface-dried, and planted in replicated two-row plots in the field with two-row plots of untreated Tift 23DB$_1$. Male-sterile mutants (whole heads, sectored heads, or heads with intermingled male-sterile and male-fertile florets) occurred at frequencies of 1 in 30,100, 1 in 515, and 1 in 274 in total head populations of 30,100, 22,700, and 19,200 treated with 0, 250, and 1000 ppM EB, respectively. Occurrence of M_1 sterile mutants that set seed when pollinated and gave rise to some cms progenies in the greenhouse proved that the mutants were cytoplasmic male sterile.

55125 Characterization of qa-2 mutants of Neurospora crassa by genetic, enzymatic, and immunological techniques. Case, M.E.; Hautala, J.A.; Giles, N.H. (Univ. of Georgia, Athens). *J. Bacteriol.;* **129**: No. 1, 166-172(Jan 1977).

Genetic and complementation mapping studies using 20 qa-2 mutants defective for catabolic dehydroquinase indicate that the qa-2 gene encodes a single polypeptide chain and is the structural gene for catabolic dehydroquinase, a 220,000-molecular-weight protein composed of identical 10,000-molecular-weight subunits. Many qa-2 mutants are capable of reversion, but no evidence has yet been obtained for nonsense mutations in this gene. The biochemical consequences of the mutations in two complementing qa-2 strains (M239 and M204) have been determined. Both mutants have extremely low levels of catalytic activity and form a heterocaryon with about 4 percent of the wild-type activity. As assayed by immunological cross-reactivity, mutant M239 and the heterocaryon have nearly wild-type levels of native-molecular-weight catabolic dehydroquinase protein, whereas M204 has no detectable amount of this protein. Thus it is conciuded that M239 has a mutation at or near the catalytic site which reduces the activity 10,000-fold but has little or no influence on the formation of the native multimeric structure. In contrast, M204 apparently has a mutation that severely inhibits aggregation and may have only a minor effect on the inherent

potential for catalytic conversion at the reactive site. The heterocaryon would appear to form a mixed multimer with the monomeric subunits from M239 providing the aggregated structure and those from M204, the catalytically active moiety.

METABOLISM

REFER ALSO TO CITATION(S) 55116, 55119, 55121, 55171, 55178, 55190

TRACER TECHNIQUES

55126 Method for obtaining more precise measures of excreted organic carbon. McKinley, K.R.; Ward, A.K.; Wetzel, R.G. (Michigan State Univ., Hickory Corners). *Limnol. Oceanogr.;* **22**: No. 3, 570-573(May 1977).

A new method for concentrating and measuring excreted organic carbon by lyophilization and scintillation counting is efficient, improves measurable radioactivity of carbon 14, and increases precision for estimates of organic carbon excreted by phytoplankton and macrophytes.

MEDICINE

REFER ALSO TO CITATION(S) 55144, 55199

55127 (HRP—0015521) **CAT scanning.** (American Association for Comprehensive Health Planning, Alexandria, Va.). Nov 1976. 177p. from American Association for Comprehensive Health Planning, 801 North Fairfax St., Suite 212, Alexandria, VA 22314.

Comprehensive information is provided on computerized axial tomography (CAT), a noninvasive diagnostic method to record an X-ray image with the use of a computer to diagnose tumors, blood clots, and other abnormalities. This publication of the American Association for Comprehensive Health Planning consists of materials submitted by Health Systems Agencies and State agencies and provides a mechanism for members of the association to share plans, concerns, potential for flexibility and growth, and competence in the management of the health dollar. Member agencies' papers cover such topics as standards for scanning, planning for CAT scanning, organization and space, scanning machinery, the economics of scanning, manpower requirements, use of computerized tomography, clinical efficacy, and quality. A final section includes a bibliography of reviewed and annotated references, unreviewed references, and health planning documents. The papers in this publication present a wide variety of viewpoints and experiences. No attempt is made to offer recommendations or to suggest positions; the intent is merely to offer alternatives on the theory that what has worked for one community is not necessarily viable in another situation.

55128 Mathematics of recirculation and the measurement of cardiac output. Dienes, J.K. (Los Alamos Scientific Lab., NM). *Math. Biosci.;* **32**: 141-153(1976).

One approach to the measurement of cardiac output has been to inject a calibrated volume of dye and measure its concentration at a point downstream. For an open system the flow rate can be found by dividing the volume of injected dye by the integral of concentration history. For closed systems, the accuracy of this procedure is limited by the effect of recirculation. In the past, approximate methods of correcting for recirculation have been used, but it is shown in this paper that an exact solution to the mathematical problem is possible, independent of any assumptions concerning the structure of the vascular bed. Specifically, the flow rate is the largest eigenvalue of an integral equation, the term eigenvalue being used in a slightly different sense than in boundary-value problems. The theory is applied to an example in which the concentration of dye in a closed system is represented by a mathematical function. The assumed cardiac output is then accurately determined by a computer program which solves the integral equation. The same procedure can be used to determine the flow rate in any closed system from the concentration history.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 55031, 55032

55129 (NTIS/PS—77/0370) **Radiodiagnostic agents and techniques. Volume 2. 1974-April 1977 (a bibliography with abstracts). Report for 1974-Apr 77.** Crockett, P.W. (National Technical Information Service, Springfield, Va. (USA)). May 1977. 284p. NTIS PCN01/MF N01.

Supersedes NTIS/PS—76/0292, and NTIS/PS—75/213.

Research reports are cited on the applications of neutrons, protons, x-rays, and radioisotopes to medical diagnosis. The topics cover data on biomedical radiography, scanning and imaging techniques including tomography, production of radiopharmaceuticals, dosimetry and health physics, equipment, and computer applications. (This updated bibliography contains 279 abstracts, 93 of which are new entries to the previous edition.) See also NTIS/PS-76/0291, Radiodiagnostic Agents and Techniques. Vol. 1. 1964-1973.

55130 Selenomethionine Se 75 thymus scans in myasthenia gravis. Toole, J.F.; Cowan, R.; Maynard, D.; Witcofski, R.L.; Janeway, R. *Trans. Am. Neurol. Assoc.;* **100**: 248-249(1975).

In 1966, Toole and Witcofski introduced selenomethionine Se 75 mediastinal scanning as a diagnostic test for thymomas. Since then we have performed such scans on patients with myasthenic syndrome. Because the technique is atraumatic, safe, and accurate, it can be performed on critically ill myasthenics. Two hundred and fifty microcuries of selenomethionine Se 75 is injected intravenously. Within 1 hour the mediastinum from the suprasternal notch to the ziphoid process is scanned, using a 2 x 3 inch scanner. Delayed scans have been made in a few instances but they have not increased the number of positive cases. Selenomethionine Se 75 is incorporated into tissues undergoing rapid protein synthesis such as thyroid, pancreas, liver, and lymphomas. Of the 34 mediastinal scans performed on myasthenics between 1966 and December 31, 1974, 4 were positive for thymoma. In addition, there was a positive scan with uptake in an area of atelectasis of the lung adjacent to the mediastinum. Of interest is the fact that 1 patient with carcinoma of the lung had a positive scan over the lesion. In 13 patients with chronic lymphatic leukemia the mediastinal scans were negative. In another patient with a mediastinal mass noted on chest x-ray, a variety of differential diagnostic possibilities were considered, such as pericardial cyst, dermoid, and aneurysm. A selenomethionine scan was strongly positive, suggesting a thymoma which subsequent surgery confirmed.

55131 Hydatid disease: rose bengal ^{131}I scanning in a case of bronchobiliary fistula. Minetto, E.; D'Onofrio, M.; Calvo, F.; Nosenzo, C.; Galli, E. *Panminerva Med.;* **18**: No. 7-8, 260-262(1976).

What is thought to be the first case of bronchobiliary fistula examined by means of Rose Bengal ^{131}I scintiscanning is reported. Emphasis is placed on the practicability and clinical value of this test, which gave more accurate information on the shape and site of the complete biliobronchial short-circuit.

55132 Serial scintigraphy during isolated renal perfusion. Fischer, D.; Hahn, K. (Univ., Mainz). *S. Afr. Med. J.;* **50**: No. 22, 854-857(22 May 1976).

A quantitative standard of radioactive impulse activity can be determined as an indicator of renal functional ability during renal transplantation and after perfusion by simple methods. Hippuran excretion is nearly absent at temperatures below 8°C but is still measurable and rises with every degree above 4°C. If there is no evidence of Hippuran excretion at 8°C, this will indicate a degree of renal damage. The examination for non-pulsatile, stored kidneys similar to the method employed by Collins appears perfectly satisfactory to us. The radioactive substances do not necessarily damage the organ because the kidneys are washed out rapidly. Similar radioactive materials can be used in pre-operative preservation and during the postoperative periods as a means of control and diagnosis without additional personnel or expenditure. In the past, false values have been obtained, owing to spasm when albumin base solutions have been used. When spasm is noted, repeated measurements should be done to determine if the spasm is true, or the result of organ damage. The basic correlation between organ weight, organ blood flow and scintigraphic impulse rates will give an initial estimate of organ activity, even when the condition of the donor kidney is unknown. Follow-up sequential scintigrams provide information regarding the suitability of the organ for transplantation.

55133 Common pitfalls of perfusion lung scan interpretation. Maniscalco, B.S.; Gonzalez, A.C.; Wenger, N.K. (Emory Univ., Atlanta). *J. Med. Assoc., Ga.;* **65**: No. 10, 383-386(Oct 1976).

Three case reports are presented in which caution must be exercised in the interpretation of abnormal lung scans. One case was a wheezing bronchial asthmatic patient; this produces perfusion abnormalities indistinguishable from those of pulmonary embolism. Ventilation lung scan studies using radioxenon would be of great assistance in this situation. A patient with a chest wall deformity had an abnormal lung scan caused by a difference in rectilinear scanner positioning in relation to lung tissue. A third case of a patient with pneumothorax illustrates the need for correlation of all data available to the clinician. The pneumothorax had many characteristics similar to those of acute pulmonary embolus. The perfusion lung scan was compatible with acute pulmonary embolus, but a chest roentgenogram clarified the problem. (HLW)

55134 Use of radioactive cesium chloride for imaging of malignant and benign pulmonary lesions. Nishiyama, H.; Lewis, J.T.; Sodd,

V.J.; Saenger, E.L. (Univ. of Cincinnati). *Surg. Gynecol. Obstet.;* **143**: No. 4, 575-580(Oct 1976).

^{129}CsCl was investigated as an agent for imaging tumors of the lung, and based on the results of 56 patients studied, it has proved to be highy sensitive in detecting primary malignant tumors of the lung. The differentiation between pulmonary malignant lesions and tuberculosis appears to be feasible. However, false-positive images in patients with benign conditions are inevitable.

55135 Radioactive technetium phosphate bone scanning in preoperative assessment and follow-up study of patients with primary cancer of the breast. Citrin, D.L.; Furnival, C.M.; Bessent, R.G.; Greig, W.R.; Bell, G.; Blumgart, L.H. (Royal Infirmary, Glasgow). *Surg. Gynecol. Obstet.;* **143**: No. 4, 360-364(Oct 1976).

Seventy-five female patients with early primary cancer of the breast were studied by bone scanning with ^{99}/super m/Tc labeled phosphate at the time of initial presentation and serially during follow-up examination. Eleven patients had an abnormal bone scan at the time of presentation. During follow-up periods, which have ranged from three to 34 months with a mean of 16 months, abnormal bone scans have developed in a further 13 patients. To date, nine of the 24 patients with an abnormal bone scan have died, while only one of the 51 with a persistently normal scan has died. It is concluded that an abnormal bone scan carries a significant risk of earlier death due to metastatic disease.

55136 Construction, restoration, and enhancement of 2 and 3-dimensional images. Cho, Z.H.; Burger, J.R. (Univ. of California, Los Angeles). *IEEE Trans. Nucl. Sci.;* **NS-24**: No. 2, 886-899(Apr 1977).

The construction of an image function from the physically measured projections of some object is discussed with reference to the least squares optimum filters, originally derived to enhance the signal-to-noise ratio in communications theory. The computerized processing associated with tomography is generalized so as to include 3 distinct parts: the construction of an image from the projection information, the restoration of a blurred, noisy image, degraded by a known space-invariant impulse response, and the further enhancement of the image, e.g., by edge sharpening. In conjuction with given versions of the popular convolution algorithm, not to be confused with filtering by a 2-dimensional convolution we consider the conditions under which a concurrent construction, restoration, and enhancement are possible. Execution speeds are compared.

55137 Clinical comparison of ^{127}Xe and ^{133}Xe for ventilation studies. Atkins, H.L.; Susskind, H.; Klopper, J.F.; Ansari, A.N.; Richards, P.; Fairchild, R.G. (Brookhaven National Lab., Upton, NY). *J. Nucl. Med.;* **18**: No. 7, 653-659(Jul 1977).

Xenon-133 and xenon-127 were compared by performing ventilation studies with both radionuclides in 19 patients with a variety of lung diseases. Assessment of the counting rate over the chest, relative to the radioactivity in the lungs, permitted the evaluation of each isotope in terms of usable photons detected by a scintillation camera with a large field of view and appropriate collimation. A greater photon yield was obtained with Xe-127. Markedly improved resolution was shown by measurement of a line phantom, but was not apparent on subjective appraisal of scintiphotos except in the washout phase. Xenon-127 appears to be preferable to Xe-133 because of the higher counting rates, lower patient radiation dose, and longer shelf life. In addition, a prior perfusion study using a Tc-99m radiopharmaceutical does not affect the quality of a Xe-127 ventilation study. The use of Xe-127 therefore permits the selection for ventilation studies of only those patients with suspected pulmonary embolism, and eliminates unnecessary radiation exposure. A further improvement in image quality obtained with Xe-127 should be possible with certain modifications of the scintillation camera that would permit use of the 375-keV photopeak along with the 172- and 203-keV gamma energies. Charcoal traps designed for Xe-133 will require additional shielding and longer storage time when used for Xe-127. Xenon-127, however, might be used again after appropriate processing.

55138 Imaging of spontaneous canine tumors with ammonia and L-glutaine labeled with N-13. Gelbard, A.S.; Christie, T.R.; Clarke, L.P.; Laughlin, J.S. (Memorial Sloan—Kettering Cancer Center, New York). *J. Nucl. Med.;* **18**: No. 7, 718-723(Jul 1977).

Ammonia and L-glutamine, labeled with N-13, were tested as imaging agents for a variety of spontaneous canine tumors. The imaging capabilities of these compounds were compared with each other, with other scanning agents, and with radiologic and pathologic procedures. Good agreement between positive gamma images and postmortem findings occurred in 11 of 15 cases with [^{13}N] ammonia as the localizing agent. Eight of the nine scans using [^{13}N] glutamine as the imaging agent showed positive correlation with postmortem findings. In cases where both ammonia and glutamine were used to image the same lesion, no qualitative differences in tumor uptake were found between the two.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 55167

55139 Synthesis of Sendai virus polypeptides by a cell-free extract from wheat germ. Davies, J.W. (Univ. of Wisconsin, Madison); Portner, A.; Kingsbury, D.W. *J. Gen. Virol.;* **33**: 117-123(1976).

The "18S" RNA population from Sendai virus-infected cells efficiently directed the synthesis of three virus-specific polypeptides P, NP and M, in wheat germ cell-free extracts. In agreement with previous results obtained with a reticulocyte extract, there was little or no production of virus glycopolypeptides. Analyses of tryptic peptides revealed close correspondence between the primary structures of NP and M made in vitro and the authentic virus polypeptides.

55140 Heat inactivation of poliovirus in wastewater sludge. Ward, R.L.; Ashley, C.S.; Moseley, R.H. (Sandia Labs., Albuquerque, NM). *Appl. Environ. Microbiol.;* **32**: No. 3, 339-346(Sep 1976).

The effect of raw and anaerobically digested sludge on heat inactivation of poliovirus was investigated. Raw sludge was found to be very protective of poliovirus plaque-forming ability at all temperatures studied, but digested sludge had variable effects that were highly dependent upon the experimental conditions. In low concentrations and at relatively low inactivation temperatures, digested sludge is nearly as protective of poliovirus as raw sludge. However, at higher temperatures and concentrations, digested sludge caused a significant acceleration of poliovirus inactivation. The difference between the protective capability of raw and digested sludge is not due to loss of protective material, because this component is present in the solids of digested sludge as well as in those of raw sludge. Instead, the difference is due to a virucidal agent acquired during digestion. Addition of this agent to the solids of either raw or digested sludge reverses the protective potential of these solids during heat treatment of poliovirus.

55141 Oxidation of arsenite to arsenate by Alcaligenes faecalis. Phillips, S.E.; Taylor, M.L. (Portland State Univ., OR). *Appl. Environ. Microbiol.;* **32**: No. 3, 392-399(Sep 1976).

Alcaligenes faecalis, resistant to the toxic effects of 0.01 M sodium arsenite, was isolated from raw sewage and shown to be capable of oxidizing arsenite to arsenate. When the organisms were grown in chemically defined medium, this conversion was due to the appearance at stationary phase of an intracellular, oxygen-sensitive, inducible enzyme and/or component of the electron transport system; when the organisms were grown in a nutrient broth-yeast extract medium, the enzyme appeared in the late exponential phase of growth. The presence of 0.02 M arsenite in the culture medium affected neither growth rate nor final cell yield.

55142 Ammonium chloride inhibits cell fusion induced by syn mutants of herpes simplex virus type 1. Holland, T.C.; Person, S. (Pennsylvania State Univ., University Park). *J. Virol.;* **23**: No. 1, 213-215(Jul 1977).

Cell fusion induced by syn mutants of herpes simplex virus type 1 is inhibited by NH_4Cl. The inhibition of fusion is both rapid and rapidly reversible and appears to be due to the NH_4^+ ion. Virus production was not significantly altered by NH_4Cl, although cell growth was greatly diminished.

TRACER TECHNIQUES

55143 Size distribution and activity of marine microheterotrophs. Azam, F.; Hodson, R.E. (Scripps Institution of Oceanography, San Diego, La Jolla, CA). *Limnol. Oceanogr.;* **22**: No. 3, 492-501(May 1977).

Natural populations of marine heterotrophic microorganisms in a variety of water masses were size fractionated with Nuclepore filters in a range of pore diameters of 0.1-8 μm. About 90 percent of the heterotrophic assimilation of ^{3}H-labeled substrates (D-glucose, acetate, and L-serine] was by organisms that pass through 1-μm filters; essentially all heterotrophic activity was by organisms passing through 5-μm filters. The 1-μm filterable fraction contained bacteria and, in some seawater samples, microflagellates. About 90 percent of the microbial heterotrophic activity in the seawater samples examined was due to those microorganisms (presumably bacteria] that are unattached to larger particulate material.

PATHOLOGY

55144 Animal model of human disease. Acute and chronic lead nephropathy. Port, C.D. (IIT Research Inst., Chicago). *Am. J. Pathol.;* **85**: No. 2, 519-522(Nov 1976).

The rat, commonly used for studies of toxicity and cellular effects of lead, has disadvantages as a model for effects on humans. The rat has spontaneous enzootic pneumonia and progressive neph-

ropathy as well as lead-induced kidney tumors. Studies with the Mongolian gerbil indicated large accumulations of lead in the kidneys, e.g., three times as much as in rats after 2 weeks of diets containing 1% lead. During 12 weeks of 0.25% dietary lead, intranuclear inclusions in epithelial cells of the proximal convoluted tubules were found. Increasing numbers of tubules containing little or no epithelium were noted. There were also cytoplasmic changes representing lead inclusions similar to those in the rat. Diets with 0.25% lead acetate, fed to gerbils for 30 months, produced chronic progressive nephropathy with tubular degeneration, interstitial fibrosis, and intranuclear inclusions. Blood cell volume and corpuscular hemoglobin values approximately 30% lower than control values indicated microcytic hypochromic anemia. Red cells exhibited anisocytosis, polychromatophilia, and basophilia: their shape varied, and many of the cells were normoblasts or reticulocytes. The chronic nephropathy and microcytic hypochromic anemia resulting from long-term administration of lead to the gerbil are comparable to those observed in man. Thus, the gerbil may be useful as a model to study chronic lead poisoning in man.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 55116, 55169, 55170, 55171, 55175, 55176, 55179, 55181, 55183, 55184

55145 Examination of photosynthetic production, excretion of photosynthetic products, and heterotrophic utilization of dissolved organic compounds with reference to results from a coastal subtropical sea. Williams, P.J.L.B.; Yentsch, C.S. (Nova Univ., Ft. Lauderdale, FL). *Mar. Biol.;* **35**: 31-40(1976).

The rate of primary production, excretion of photosynthetic products and turnover of glucose and amino acids was measured at a station in a coastal region in the Bahamas. Over the depths 0 to 50 m, total photosynthetic rates varied from 1.7 to 12.7 μgC fixed l^{-1} day^{-1}, averaging 4.3. The extent of extracellular photosynthetic products ranged from undetectable to 23%, averaging 6.9%. Neither the field data nor studies with axenic cultures of Dunaliella tertiolecta, Skeletonema costatum, and Monochrysis lutheri showed any evidence of an increase in the percentage excretion at low population densities or low photosynthetic rates. Rates of amino acid turnover varied from 21 to 168% day^{-1}, and that of glucose from 8.3 to 41% day^{-1}. Light seems to have little effect on the uptake and respiration of these substrates by the planktonic population. There was a significant relationship between the fraction of the substrate used for respiration and that retained by the cell. On average, 42% of the glucose taken up was respired and 21% of the amino acid mixture. Tentative calculations suggest that the production of dissolved organic material as extracellular photosynthetic products would be insufficient to supply the heterotrophic population, and it was concluded that some other route(s) must be of major importance.

55146 Artificial organs and transplantation. Kolff, W.J. (Univ. of Utah, Salt Lake City). *Transplant. Proc.;* **9**: No. 1, liii-lxiii(Mar 1977).

From 6. international congress of the Transplantation Society proceedings; New York, NY, USA (22 Aug 1976).

The status of development of artificial organs in 1977 is reviewed. A small, wearable battery-powered artificial kidney weighing about 8 lb and using a hollow fiber dialyzer is described that has been proved effective for home dialysis of patients. Results of tests of the performance of artificial hearts in calves, improvements in the development of artificial arms, and preliminary results in development of artificial eyes and artificial ears are reported. (CH)

55147 Reversal of experimental diabetes by fetal rat pancreas. I. Survival and function of fetal rat pancreas frozen to -196°C. Kemp, J.A.; Mazur, P.; Mullen, Y.; Miller, R.H.; Clark, W.; Brown, J. (Univ. of California, Los Angeles). *Transplant. Proc.;* **9**: No. 1, 325-328(Mar 1977).

From 6. international congress of the Transplantation Society proceedings; New York, NY, USA (22 Aug 1976).

Pancreatic rudiments from fetal rats were frozen and held at -196°C for approximately 9 to 13 weeks and then transplanted into allogeneic animals. In all cases the transplanted tissues became well vascularized within three to five days and showed significant increases in both area and mass within eleven days. Insulin synthesis in the cryopreserved pancreas tissues was demonstrated by ability to reverse experimental diabetes in four rats. (CH)

55148 Decreased surface charge and accelerated senescence of red blood cells following neuraminidase treatment. Landaw, S.A.; Tenforde, T.; Schooley, J.C. (Univ. of California, Berkeley). *J. Lab. Clin. Med.;* **89**: No. 3, 581-591(Mar 1977).

Female LAF_1 mice were given single or repeated injections of V. cholerae N'ase and the effects on circulating RBC surface charge and life span were determined. Intravenous injection of N'ase caused a rapid decrease in RBC surface charge of approximately 14 percent, and survival of such treated cells was reduced by approximately one fifth by virtue of an acceleration of senescence. When RBC's were treated in vitro with N'ase, a comparable (14 to 17 percent) reduction in surface charge was seen. Such cells, when injected into intact mice, showed a similar acceleration of senescence. When N'ase was injected intravenously into splenectomized mice, RBC survival was similar to that of controls. Intravenous injection of N'ase 1 hour before injection of labeled RBC's did not alter RBC survival nor did it accelerate the clearance of carbon particles by the RES. These results indicate that N'ase accelerates senescence in treated mouse erythrocytes by acting on the RBC's and not by activating the RES. Absence of this effect in splenectomized mice inplicates the spleen as the sensor of the induced alterations in surface charge. These results and those recently reported for treated RBC's in the dog, rat, rabbit, and man suggest that at least a portion of the phenomenon of RBC senescence may be related to the loss of RBC surface charge.

TRACER TECHNIQUES

55149 Squamous cell differentiation in a clonal teratocarcinoma cell line. Swartzendruber, D.E. (Los Alamos Scientific Lab., NM). *Differentiation;* **7**: 7-12(1976).

Several clonal teratocarcinoma cell lines restricted to squamous cell differentiation have been established from a subculture of totipotential murine teratocarcinoma stem cells. These lines contain a continuum of cell types from less differentiated precursor cells to differentiated squamous cells. In contrast to their highly malignant progenitors, these cells are nontumorigenic. Chromosomally, the cells are near-tetraploid, and their DNA distributions are tetraploid. These cell lines may prove useful in the study of normal squamous cell differentiation and also will be important in studies concerning the conversion of malignant cells to non-malignant progeny.

55150 Divalent cation ionophore A23187: a potent protein synthesis inhibitor. Bottenstein, J.E.; de Vellis, J. (Univ. of California, Los Angeles). *Biochem. Biophys. Res. Commun.;* **73**: No. 2, 486-493(1976).

Divalent cation ionophore A23187 has a potent inhibitory effect on protein synthesis in the C6 rat glioma cell line. Treatment with 4 μM A23187 resulted in 93% inhibition of [1-^{14}C]leucine label incorporation into proteins and a 61% increase in free pool labeling. Total RNA synthesis was not affected. Extracellular ionic calcium or magnesium are not required for these changes to occur. Therefore, these effects of A23187 may be a direct effect on protein synthesis or may result from release of internal stores of divalent cations. By comparison, ionophore X537A (4 μM) has only a slight inhibitory effect on protein synthesis.

55151 Excretion of dissolved organic carbon by eelgrass (Zostera marina) and its epiphytes. Penhale, P.A. (Atlantic Estuarine Fisheries Center, Beaufort, NC); Smith, W.O. Jr. *Limnol. Oceanogr.;* **22**: No. 3, 400-407(May 1977).

The release of dissolved organic carbon (DOC) by eelgrass (Zostera marina) and its epiphytic community was examined in a shallow estuarine system near Beaufort, North Carolina. Excretion by eelgrass alone, by epiphytes alone, and by heavily epiphytized eelgrass was determined by radiocarbon techniques using carbon 14. The percent of total photosynthate excreted was small in all cases: 0.9 percent for heavily colonized plants, 1.5 percent for Zostera alone, and 2.0 percent for the epiphytic community. The amount released by the eelgrass and epiphytes was proportional to the total amount of carbon fixed. Excretion rates in the dark were much lower than in the light. The rate of excretion increased after the plant underwent desiccation. The annual primary production and DOC excretion by phytoplankton, cordgrass (Spartina alterniflora), and the eelgrass community was estimated: 47 percent of the total annual primary production and 14 percent of the total excreted material was contributed by eelgrass and its epiphytes. Thus the eelgrass and epiphytes can play an important role in carbon cycling in estuarine systems.

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 55052, 55124

55152 Simulation model for nutrient uptake from soil by a growing plant root system. Claassen, N.; Barber, S.A. (Purdue Univ., Lafayette, IN). *Agron. J.;* **68**: 961-964(1976).

Mathematical models of nutrient uptake by plants are useful for investigating the effect of various soil and plant factors on nutrient flux to plant roots. The objective of this research was to develop a model based on theoretical considerations of the processes of nutrient uptake by plant roots growing in soil and then to test the model experimentally. The soil and plant factors used in the model were to be measured independent of final nutrient uptake. The model

for flux by mass flow and diffusion to the root was patterned after that of Nye and Marriott. The absorption kinetics of the root were assumed to follow Michaelis-Menten kinetics. The Nye-Marriott model gives the nutrient concentration at the root with time. From this accumulated uptake per cm^2 of root surface with time was calculated. Rate of root growth was assumed exponential for the growth of the young plant. Uptake per cm^2 of root with time was combined mathematically with rate of root growth to get total uptake with time by the plant. The present program assumes root hairs do not affect uptake and that roots do not compete for nutrients. A computer program was written for solution of the mathematical model. The factors required in the model from the soil are: effective average diffusion coefficient, initial nutrient concentration in solution, and buffering capacity. For the plant they are: the relation between nutrient concentration in solution and net influx into the root, water influx, root radius, initial root length, and rate of root growth. The model should be useful for investigating the principles of nutrient absorption by plant roots from soil which can be used for developing more efficient systems of fertilizer application.

55153 Scheme for sampling inorganic nitrogen in forest soils. Northup, M.L.; MacCormick, A.J.A.; Boyle, J.R. (Univ. of Wisconsin, Madison). *Commun. Soil Sci. Plant Anal.;* **8**: No. 4, 289-296(1977).

An efficient sampling scheme for evaluating seasonal changes of inorganic nitrogen in a forest soil was designed. It was based on variances of ammonium- and nitrate-nitrogen estimated from core samples from each of three horizons (A1, A2, B1) taken from 8 randomly selected sites in a three-hectare study area. The scheme adopted was: At each sampling time a single composite sample for each horizon was made using 15 cores from randomly-selected locations; duplicate subsamples from each composite were analyzed for ammonium- and nitrate-nitrogen.

55154 Effects of ingested soil on ration utilization by dairy cows. Miller, J.K.; Madsen, F.C.; Swanson, E.W. (Comparative Animal Research Lab., Oak Ridge, TN). *J. Dairy Sci.;* **60**: No. 4, 618-622(Apr 1977).

Six nonpregnant, nonlactating Holstein cows were fed 3.6 kg concentrate, hay ad libitum, and 0, 450, or 900 g red clay subsoil daily in two 3 x 3 Latin squares. Effects of added soil on apparent digestibility were increases of 20 and 19% for ether extract, decreases of 5 and 9% for dry matter and 2 and 6% for protein, and no effect for organic matter, crude fiber, nitrogen-free extract, and combustible energy. Apparent absorption of potassium was reduced 12 and 25% by increasing soil intake, but absorptions of magnesium, calcium, and phosphorus were not altered. These results indicate that amounts of soil which are likely to be consumed under normal and sparse grazing would not have an important effect on utilization of most major dietary nutrients.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON CELLS

55155 Mechanisms of laser damage to Chlorella cells. Gavrilov, A.G.; Piskunkova, N.F.; Rubin, L.B. (M. V. Lomonosov State University, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 4, 422-424(Apr 1977).

A study was made of the interaction of laser radiation with Chlorella microalgae cells. The cell damage was found to be a function of the laser wavelength and power, and of the temperature of the cell suspension during irradiation. Possible damage mechanisms were considered, including local heating due to absorption of ruby laser radiation by intracell pigments when energy migration processes were saturated, heating-induced breaking of molecular bonds, and subsequent denaturation of biological membranes. These hypotheses were confirmed by spectrometric and pyrometric measurements.

RADIATION EFFECTS ON ANIMALS

MAN

55156 (AD-A—038872) Nuclear emulsion measurements of the dose contribution from tissue disintegration stars on the apollo-soyuz mission. Technical report No. 2, Jul 76—Mar 77. Schaefer, H.J. (West Florida Univ., Pensacola (USA)). 15 Mar 1977. Contract N00014-76-C-0544. 15p. NTIS PCA02/MF A01.

Analysis of the prong number distribution of a population of disintegration stars in nuclear emulsion allows a quantitative estimate of the fraction of stars originating in the gelatin matrix and thereby an assessment of the tissue-equivalent dose from stars. 996 stars were prong-counted in two 100 micron Ilford K.2 emulsions from the dosimeter of the Docking Pilot on Apollo-Soyuz and furnished a tissue star dose of 7.8 millirad or 45 millirem. Since star-produced neutrons do not leave visible prongs in emulsion, their dose contribution is not included. Nuclear theory as well as earlier measurements of galactic radiation in the Earth's atmosphere indicate that the dose equivalent from neutrons is about equal to the one from all ionizing secondaries from stars. This would set the total tissue star dose for Apollo-Soyuz at approximately 90 millirem. (Author)

55157 (AD-A—038925) Laser-protection eyewear: preliminary results from colorfastness testing. Interim report Jul 75—Jun 76. Fodor, W.J. (School of Aerospace Medicine, Brooks AFB, Tex. (USA)). Dec 1976. 14p. (SAM-TR—76-45). NTIS PCA02/MF A01.

Original contains color plates: All DDC and NTIS reproductions will be in black and white.

Samples of selected laser-protection eyewear were tested for a 3-month period in the colorfastness part of the USAFSAM Laser-Protection Eyewear Evaluation Program. Results included some moderate to severe changes in optical density (OD), measured by a laser OD system, as well as changes in haze and refraction. Some protection devices underwent severe structural changes as a result of testing. A follow-on study to determine an appropriate revised cutoff for colorfastness testing is briefly described.

55158 Efficacy of prophylactic irradiation in altering renal allograft survival. Faber, R.; Johnson, H.K.; Braren, H.V.; Richie, R.E. (Vanderbilt Univ., Nashville). *Proc. Clin. Dial. Transplant Forum;* **4**: 135-137(1974).

Renal allograft rejection is a complex phenomenon involving both cell-mediated and humoral antibody responses. Most transplant programs have used a combination of therapeutic modalites to combat the immune system in an attempt to prolong both allograft and patient survival. Corticosteroids (methylprednisolone (Solu-Medrol) and prednisone and azathioprine (Imuran) are widely accepted as immunosuppressive drugs; however, both are non-specific and have the disadvantage of compromising the recipients' defense mechanisms. Nevertheless, these drugs have proved to be essential to the success of renal transplantation and they are routinely used while the efficacy of other modalities continues to be evaluated. We could find no reports of a prospective study to evaluate the efficacy of prophylactic irradiation in the complex therapeutic situation of renal transplantation with the only variable being the administration of local graft irradiation. The purpose of this study was to evaluate prophylactic graft irradiation for its effectiveness in preventing graft rejection in conjunction with Imuran and corticosteroids.

55159 Irradiation and thyroid carcinoma: legacy and controversy. Frohman, L.A. (Michael Reese Medical Center, Chicago). *J. Chronic Dis.;* **29**: No. 10, 609-612(Oct 1976).

Some topics discussed are as follows: thyroid carcinoma in populations exposed to thermonuclear fallout in Japan and the Marshallese Islands; high frequency of prior head and neck irradiation in patients with thyroid carcinoma; nodular thyroid disease in patients following radiotherapy of tonsils and nasopharyngeal region; use of plasma thyroglobulin level and /sup 99m/Tc-pertechnetate for detecting thyroid carcinoma; analysis of risk factors and prediction of future occurrence of tumors; surgical procedures for thyroid carcinomas; and the role of thyroxine suppressive therapy. (HLW)

55160 Total-body irradiation and marrow transplantation. Storb, R. (Univ. of Washington, Seattle). *Transplant. Proc.;* **9**: No. 1, 1113-1119(Mar 1977).

From 6. international congress of the Transplantation Society proceedings; New York, NY, USA (22 Aug 1976).

Data are reviewed from a number of studies on patients with hematologic malignancies treated with transplanted bone marrow cells following total-body irradiation. The fact that increasing numbers of disease-free marrow graft recipients following total-body irradiation have survived for years indicates the feasibility of the treatment, especially since the patients had reached the terminal phase of their leukemia at the time of grafting. (CH)

INVERTEBRATES

55161 Mating frequency of normal vs sterile male boll weevils in the laboratory. Nilakhe, S.S. (Louisiana State Univ., Baton Rouge); Earle, N.W. *J. Econ. Entomol.;* **69**: No. 4, 459-461(16 Aug 1976).

Male Anthonomus grandis Boheman, treated with a combination of γ irradiation and hempa in the diet, mated ca. one-half as often as untreated males when paired individually with 4 virgin females/day. Examination of spermathecae showed that females mated to treated males contained an average of ca. $^1/_3$ as much sperm as females mated to untreated males. Thus, considering spermathecal filling and mating frequency, treated males transferred only ca. $^1/_6$ as much sperm as untreated males. When paired with females immediately after treatment, treated males inseminated an average of

18.3 female before aspermia occurred; however, when treated males were first held without females for 10 days, they were capable of inseminating an average of only 4.1 females.

55162 Inherited sterility in progeny of irradiated male sugarcane borers. Sanford, J.W. (Dept. of Agricultural, Houma, LA). *J. Econ. Entomol.;* **69**: No. 4, 456-458(16 Aug 1976).

When male Diatraea saccharalis (F.) were irradiated with 5, 10, or 15 krad of irradiation (cobalt 60) and crossed with unirradiated females, fertility and fecundity showed a dose-dependent reduction with increasing dose. Also, the F_1 progeny of these crosses was more sterile than the irradiated male parents. When the dose to the P_1 male was 10 or 15 krad, the fecundity of the F_1 progeny was significantly reduced. Both normal females crossed with irradiated P_1 males and the F_1 male progeny showed an increased frequency of mating. F_1 progeny had longer development time when the P_1 male was treated with 10 or 15 krad. F_1 progeny mortality and sex ratio showed a dose dependent response, with each increasing as the dose to the P_1 male increased.

55163 Embryonic development in house fly eggs fertilized with genetically deficient sperm. LaChance, L.E.; Richard, R.D.; Johnson, O.A.; Belich, C. (Agricultural Research Service, Fargo, ND). *Genetics;* **86**: No. 2, 377-388(Jun 1977).

In house flies, Musca domestica L., eggs fertilized with sperm that have chromosome deficiencies and duplications do not hatch, but develop to a stage where a fully differentiated, prehatch larva is formed. Fifteen different chromosome translocations involving most of the 10 arms of the 5 autosomes were studied by crossing male translocation heterozygotes to normal females. Egg hatch was reduced to 36 to 66% depending on the translocation used. Eggs that did not hatch after 24 hours were fixed, stained, and examined for stage of development. Several translocations involving the right arm of chromosome 4 indicate that the region closest to the centromere contains genes that affect the process of syngamy or early cleavage divisions, but do not reduce the ability of the sperm to complete for egg fertilization. Approximately 70% of the autosomal genes can be absent from sperm (not simultaneously but in different crosses) without inhibiting embryonic development.

55164 Experimental population genetics of meiotic drive systems. I. Pseudo-Y chromosomal drive as a means of eliminating cage populations of Drosophila melanogaster. Lyttle, T.W. (Univ. of Wisconsin, Madison). *Genetics;* **86**: No. 2, 413-445(Jun 1977).

The experimental population genetics of Y-chromosome drive in Drosophila melanogaster is approximated by studying the behavior of T(Y;2),SD lines. These exhibit "pseudo-Y" drive through the effective coupling of the Y chromosome to the second chromosome meiotic drive locus, segregation distorter (SD). T(Y;2),SD males consequently produce only male offspring. When such lines are allowed to compete against structurally normal SD+ flies in population cages, T(Y;2),SD males increase in frequency according to the dynamics of a simple haploid selection model until the cage population is eliminated as a result of a deficiency in the number of adult females. Cage population extinction generally occurs within about seven generations.

PEST CONTROL

REFER ALSO TO CITATION(S) 55161, 55162

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

REFER ALSO TO CITATION(S) 55030

55165 (CONF-760992—17) **Model for the induction of bone cancer by ^{224}Ra.** Groer, P.G.; Marshall, J.H. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 14p. Dep. NTIS, PC A02/MF A01.

From 2. international symposium on biological effects of Ra-224; Neuherberg/Muenchen, German, Federal Republic of (F.R. Germany) (20 Sep 1976).

A mathematical model for the transformation of normal endosteal cells into malignant tumor cells by α irradiation is applied to ^{224}Ra. The model postulates that a normal endosteal cell near the bone surface is transformed into a malignant cell by three consecutive events. The first two events are the initiation events. The probability of their occurrence is proportional to the absorbed endosteal dose and they generate dormant tumor cells. These dormant tumor cells are promoted by the third event, the promotion event. The probability of this last event is proportional to the rate of bone remodeling but independent of the radiation dose. In competition with these transforming events is the killing of any endosteal cell by α irradiation. Killing is balanced by replacement of killed endosteal cells by normal stem cells. This model provides the following interesting predictions for the human ^{224}Ra cases: after the decay of ^{224}Ra the tumor rate decreases exponentially at a rate proportional to the bone turnover rate; for exposure to the same dose the model predicts an increased number of tumors for protracted exposure (i.e., exposure at a lower dose rate). Implications of this model for the therapy of ankylosing spondylitis are discussed. Statistical procedures are suggested for comparison of this theoretical model with the existing data on the induction of osteosarcomas by ^{224}Ra in man.

NUCLIDE KINETICS AND TOXICOLOGY

ANIMALS

55166 Absorption, excretion, and tissue deposition of titanium in sheep. Miller, J.K.; Madsen, F.C.; Hansard, S.L. (Comparative Animal Research Lab., Oak Ridge, TN). *J. Dairy Sci.;* **59**: 2008-2010(Nov 1976).

Titanium metabolism was measured in three 18 kg lambs each fed 450 g chopped hay daily. Two of the lambs were dosed orally and one intravenously with 3 μCi titanium-44 each. Clearance of the intravenous dose was extremely slow; after oral administration, however, no titanium-44 was detected in blood plasma for 48 h. Over 96% of the oral dose was recovered in feces and digestive tract contents. Titanium-44 absorption, estimated from total carcass recovery and by comparison of concentrations in internal organs of orally and intravenously dosed lambs, was less than .5%. Fecal titanium could be a satisfactory index of soil ingestion by grazing ruminants.

THERMAL EFFECTS

MICROORGANISMS

REFER ALSO TO CITATION(S) 55140

55167 Multiplication rate of amoebae related to the cultivation temperature. Sopina, V.A. (Inst. of Cytology, Leningrad). *J. Therm. Biol.;* **1**: No. 4, 199-204(Oct 1976).

The cultivation temperature-dependent rate of multiplication in amoebae was studied using three strains of Amoeba proteus and another amoeba strain of unknown specific and generic position. The multiplication rates are characterized by optima that vary with strains. The temperature-induced changes in the multiplication rate of a given strain are non-hereditary; they are common modifications. Hereditary interstrain differences in the multiplication rate have also been shown at constant temperatures. The range of modificational changes with increase or decrease of cultivation temperature appears to be greater than interstrain differences in multiplication rate.

55168 Temperature effects on BOD stoichiometry and oxygen uptake rate. Flegal, T.M. (Brown and Caldwell Consulting Engineers, Walnut Creek, CA); Schroeder, E.D. *J. Water Pollut. Control Fed.;* **48**: No. 12, 2700-2707(Dec 1976).

A respirometric study was conducted to determine the effect of incubation temperature on oxygen uptake rate and stoichiometry of the plateau in uptake rate representing end of primary substrate conversion to carbon dioxide and cells. Typical curves with clearly discernible plateaus were obtained. Plateau stoichiometry apparently is not greatly affected by changes in temperature up to 37°C; thus, when the plateau is used as a reference point in the biochemical oxygen demand test, constant-temperature incubation usually is not necessary. The plateau value for glutamic acid (0.398 mg oxygen/mg) was very close to values reported elsewhere. Shorter run times to the plateau resulted from increasing temperatures.

INVERTEBRATES

55169 Heat death in the crayfish Austropotamobius pallipes: thermal inactivation of muscle membrane-bound ATPases in warm and cold adapted animals. Gladwell, R.T. (Univ. of Reading, Eng.). *J. Therm. Biol.;* **1**: No. 2, 95-100(Jan 1976).

The thermal sensitivity of the membrane-bound Mg^{2+} and $Na^+ + K^+ + Mg^{2+}$ ATPases from the abdominal flexor muscles of 10 and 25°C acclimated animals was investigated. The Mg^{2+} ATPase was inactivated by milder heat treatments than the $Na^+ + K^+ + Mg^{2+}$ ATPase. The effect of high lethal temperatures on the Mg^{2+} ATPase was dependent on the previous thermal history of the animal, the enzyme preparations from 10°C acclimated animals being more sensitive than those from 25°C acclimated animals. The thermal sensitivity of the $Na^+ + K^+ + Mg^{2+}$ ATPase was not altered by temperature acclimation. The change in the thermal sensitivity of the Mg^{2+} ATPase with the acclimation temperature of the whole animal was correlated with the survival times of 10 and 25°C acclimated animals. The K/sub m/ and V/sub max/ of the

ATPases was investigated and the K/sub m/ of both enzymes was found to decrease with acclimation of the whole animal to lower temperatures, so that enzyme/substrate affinity increased with cold acclimation. It was concluded that the inactivation of the muscle Mg^{2+} ATPase was the primary lesion of heat death in the crayfish, and that the changes in the kinetic properties of the ATPases were an important mechanism in the process of physiological temperature acclimation.

55170 Heat death in crayfish Austropotamobius pallipes: ion movements and their effects on excitable tissues during heat death. Gladwell, R.T. (Univ. of Reading, Eng.); Bowler, K.; Duncan, C.J. *J. Therm. Biol.;* **1**: No. 2, 79-94(Jan 1976).

Resistance acclimation has been demonstrated in the crayfish Austropotamobius pallipes. Analysis of muscle, hemolymph and environment showed that dramatic changes occurred in the Na^+ and K^+ concentrations in all three compartments during exposure to high lethal temperatures. Ions tended to move along their electrochemical gradients. Results indicate that death is related to a rise in hemolymph K^+ concentration, no relationship between Na^+ concentration and heat death was observed. Exposure to high lethal temperatures cause an increase in sarcolemmal conductivity. Concomitant with this is a fall in resting potential of the muscle fibers, the time-course of which is dependent upon the previous thermal history of the animal. Muscle fiber resting potential of "heat dead" crayfish was found to be normal when measured in "normal" saline and at room temperature. Spontaneous activity of the CNS was relatively unaffected by exposure to high lethal temperatures, with a Q_{10} of 1.3. Raising the extracellular K^+ concentrations to levels observed in animals at the time of heat death caused a massive increase in activity. A sequence of events occurring during heat death is proposed and the implications of this to the possible mechanisms involved in thermal acclimation are discussed.

55171 Influence of acclimation and determination temperature on the oxygen consumption of the brain in two species of anurans. Lascano, E.C.; Depaoli, J.R.; Segura, E.T. (National Medical Academy, Buenos Aires). *J. Therm. Biol.;* **1**: No. 4, 209-212(Oct 1976).

The effects of sudden changes by increasing or decreasing the measurement temperature on the oxygen consumption of the brains of Bufo arenarum and Leptodactylus ocellatus were determined. The experiments were carried at in vitro at temperatures which ranged from 4 to 37°C. The brain was oxygenated and stabilized for 20 min at each of the temperatures to which it was subjected before oxygen consumption measurements were made. A theoretical curve representing the variation of oxygen consumption with temperature was calculated according to the following exponential relationship; for Leptodactylus ocellatus y = 0.408 x 1.07/sup x/ and for Bufo arenarum y = 0.389 x 1.065/sup x/. These results were compared with the brain oxygen consumption of animals acclimated to different temperatures, whose oxygen consumption was measured at a fixed temperature. Only Leptodactylus ocellatus had a significantly lower oxygen consumption in a high range of temperatures, indicating thermal compensation, probably to save metabolic reserves. No deterioration of the brain tissue was observed, as several passages from high to low temperatures in the range of 20 to 30°C, showed a reversible oxygen consumption in acclimated and non-acclimated Bufo arenarum and Leptodactylus ocellatus.

55172 Ecophysiology of some marine nematodes from Bermuda: seasonal aspects. Wieser, W. (Univ., Innsbruck); Schiemer, F. *J. Exp. Mar. Biol. Ecol.;* **26**: No. 1, 97-106(Jan 1977).

In the winter of 1976 the horizontal and vertical distribution, temperature tolerance, and oxygen consumption at three experimental temperatures were determined for several species of nematodes inhabiting a low-energy beach in Bermuda. The results are compared with those of previous summer investigations carried out on the same beach. The three most abundant species of nematodes on the beach, Steineria sterreri Ott, Trefusia schiemeri Ott and Theristus floridanus Wieser and Hopper show distinct patterns of distribution as well as distinct survival-time curves when upper lethal temperature is plotted against exposure time. No seasonal resistance adaptation to high temperature occurs in Steineria sterreri and Trefusia schiemeri, the two species for which comparative summer data are available. Theristus erectus, which dominated the flat in summer, is much more heat tolerant than T. floridanus which replaced it in winter. Oxygen consumption at 15°C is twice as high in T. floridanus as in Trefusia schiemeri, whereas at 22° and 30°C both species consume approximately the same amount of oxygen. T. schiemeri is capable of seasonal adaptation of Q/sub O_2 inasmuch as it consumes just about as much oxygen in winter at 22°C as in summer at 30°C. The seasonal data support the suggestion that on a subtropical low-energy beach the metabolic capacities of many meiofauna species are closely adjusted to the micro-environment in which they live.

55173 Effect of photoperiod on diapause induction, and temperature on diapause termination in embryos of Aedes campestris Dyar and Knab (Diptera: Culicidae). Tauthong, P.; Brust, R.A. (Univ. of Manitoba, Winnipeg). *Can. J. Zool.;* **55**: No. 1, 129-134(Jan 1977).

Populations of Aedes campestris from Manitoba and Saskatchewan were found to be either multivoltine or univoltine depending upon the geographical region from which the adults were collected. Three southern populations (from 49 to 52°N) were found to be totally multivoltine, whereas a northern population (58°N) was found to be partially (36 percent) univoltine. The latter fraction was designated as univoltine because the eggs entered an obligatory diapause after oviposition. When univoltine eggs were placed at 30°C for a period of 10 days, 59 percent of the eggs hatched when subjected to a hatching stimulus. Facultative dispause was induced in eggs of multivoltine populations of A. campestris, by subjecting fully embryonated eggs to photoperiods of less than 14 h per day. For example, after 30 days at 8 h light:16 h dark 73 percent of the eggs entered diapause.

55174 Effect of temperature on the development and survival of two populations of Aedes campestris Dyar and Knab (Diptera: Culicidae). Tauthong, P.; Brust, T.A. (Univ. of Manitoba, Winnipeg). *Can. J. Zool.;* **55**: No. 1, 135-137(Jan 1977).

Larvae of A. campestris from Saskatoon, Saskatchewan, and Churchill, Manitoba, were reared at constant temperatures of 15, 20, 23, 25, and 27°C. Larvae of both populations failed to complete their development to adults at 15°C, although development to third- and fourth-instar larvae did occur and survival at this temperature was greatest in the population from Saskatoon. The optimum developmental temperature for both populations was found to be 23°C. The development rate and the survival rate was higher in the Churchill population at temperatures above 20°C. At 15°C, contrary to what would be expected, survival of larvae was much greater in the more southern (Saskatoon) population.

VERTEBRATES

55175 Mathematical biothermal model of the California sea lion. Luecke, R.H.; Natarajan, V.; South, F.E. (Univ. of Missouri, Columbia). *J. Therm. Biol.;* **1**: No. 1, 35-45(Oct 1975).

The thermal behavior of the California sea lion is modeled by a set of seventeen simultaneous partial differential equations. Numerical solution of these equations yields temperature profiles in the sea lion that closely reproduce experimental data obtained with the animals at rest in air. The model predicts that exercise is necessary to maintain body temperature while immersed in very cold water (0°C) but that very efficient heat conservation occurs during diving because of bradycardia, limited circulation, and absence of respiration.

55176 Effects of photoperiod-temperature regimes on pituitary gonadotrophs, pituitary gonadotropin potency, and hypothalamic gonadotropin releasing activity in the teleost Notemigonus crysoleucas. de Vlaming, V.L.; Vodicnik, M.J. (Marquette Univ., Milwaukee). *J. Therm. Biol.;* **1**: No. 2, 119-125(Jan 1976).

The effects of various photoperiod-temperature regimes on gonadal activity, hypothalamic gonadotropin releasing activity, pituitary gonadotropin potency and pituitary gonadotrophs were examined in the teleost, Notemigonus crysoleucas. In fish maintained on a long photoperiod-high temperature regime final gonadal maturation occurs. Under these conditions by hypothalamic gonadotropin releasing activity is high, stainable gonadotrophs make up a low percentage of pituitary area and pituitary gonadotropin potency is relatively low. Gonadotrophs make up a relatively large area of the pituitary and adenohypophyseal gonadotropin activity is high in fish exposed to long photophotoperiod-low temperature regimes. Long photoperiod-low temperature regimes do not stimulate final gonadal maturation. Short photoperiod-high temperature conditions retard gonadal development or cause gonadal regression in Notemigonus. The area of the pituitary occupied by gonadotrophs and hypothalamic gonadotropin releasing activity are low in fish exposed to these conditions. Pituitary gonadotropin potency, however, is relatively high in fish maintained on short photoperiod-high temperature regimes. Gonadotrophs were infrequent in the pituitary and pituitary gonadotropin potency was low in animals maintained on short photoperiod-low temperature regimes. These conditions do not promote the final stages of gonadal maturation in Notemigonus. Light intensities of below 151x are insufficient to induce spawning in Notemigonus. Light intensities above 151x increase the incidence of spawning.

55177 Variation in myelin lipid composition induced by change in environmental temperature of goldfish (Carassius auratus L.). Selivonchick, D.P.; Roots, B.I. (Univ. of Toronto, Mississauga, Ont.). *J. Therm. Biol.;* **1**: No. 3, 131-135(Apr 1976).

Goldfish (Carassius auratus L.) were acclimated to 5, 15, and 30°C, and the lipid and protein composition of brain and spinal cord myelin was determined. Goldfish myelin contains less galactolipid, but more protein and phospholipid than mammalian and bird myelin. Phosphatidyl choline was the predominant phospholipid in both brain and spinal cord myelin. Fish myelin also showed a greater plasmalogen content with an average ethanolamine plasmalogen/total phosphatidyl ethanolamine ratio of 0.84. Total brain and myelin lipids, with the exception of plasmalogens, showed a resistance to

change with thermal acclimation. Differences between brain and spinal cord myelin protein and phospholipids were not observed. It is suggested that temperature acclimation in poikilotherms may be used as a tool in the study of membrane adaptability.

55178 Role of fatigue in temperature resistance of salamanders. Burke, E.M.; Pough, F.H. (Cornell Univ., Ithaca, NY). *J. Therm. Biol.;* **1**: No. 3, 163-167(Apr 1976).

We measured temperature resistance and lactic acid production of Notophthalmus viridescens and Plethodon cinerus acclimated to 10, 20 or 30°C. Fatigue is responsible for the Loss of Righting Response (LRR) observed when Plethodon are heated and contributes to the LRR of Notophthalmus efts. LRR is purely a manifestation of incapacitation by high temperature in Notophthalmus adults. The Critical Thermal Maximum (CTM) is solely a product of temperature incapacitation in all three forms. The standard test for temperature resistance should be expanded to include tests of fatigue.

55179 Perception of abrupt temperature decrease by restrained skipjack tuna, Katsuwonus pelamis. Dizon, A.E.; Byles, T.C.; Stevens, E.D. (NOAA, Honolulu, Hawaii). *J. Therm. Biol.;* **1**: No. 3, 185-187(Apr 1976).

Decreasing temperature stimuli produced responses and threshold similar to those produced by increasing temperature stimuli in a previous study with skipjack tuna. Katsuwonus pelamis. Restrained skipjack tuna signaled by deceleration of heart rate that they could perceive abrupt temperature decreases (0.5°C/sec) as small as 1 to 2°C. Temperature stimulation of the oral-branchial cavity was more effective in eliciting responses than stimulation of the dorsal, anterior quadrant of the body surface.

55180 Temperature tolerance and preference of immature channel catfish (Ictalurus punctatus). Cheetham, J.L.; Garten, C.T. Jr.; King, C.L.; Smith, M.H. (Savannah River Ecology Lab., Aiken, SC). Contract AT(38-1)-819. *Copeia;* No. 3, 609-612(20 Aug 1976).

Objectives of the experiment were (1) to estimate the temperature tolerance and preference of channel catfish acclimated at six different temperatures and (2) to investigate relationships among temperature tolerance, temperature preference and acclimation temperature. In the thermal gradient the fish consistently chose temperatures higher than their acclimation temperature if they were acclimated at 12, 16, 20, or 24°C, and a lower temperature when acclimated at 28 and 32°C. This suggests that the fish were selecting optimum temperatures of 28 to 30°C. Results also demonstrated a strong relationship between thermal tolerance, thermal preference and acclimation temperature. (CUJ)

55181 Effects of high temperature and low calcium on neuromuscular transmission in frog. White, R. (Univ. of Illinois, Urbana). *J. Therm. Biol.;* **1**: No. 4, 227-232(Oct 1976).

The neuromuscular junction of the frog cutaneous pectoris was more readily blocked by heat than were either the motor nerve or the muscle. Neuromuscular heat block occurred at 36°C for preparations bathed in 1.0 or 0.5 mM Ca^{2+} and at 33°C for preparations bathed in "calcium free" Ringer. Heat block at 36°C did not involve cessation of mepp's whereas beyond the temperature of heat block in 0.0 mM Ca^{2+} no mepp's occurred. Increasing temperature caused a linear decrease in mepp amplitude and duration, while postsynaptic mepp's to iontophoretically applied acetylcholine increased. The results from above indicate that the effects of heat are greater on the presynaptic endings and that there is an intracellular store of Ca^{2+} which is depleted under conditions of zero external calcium and heat. Increasing temperature caused a logarithmic increase in mepp frequency as a function of temperatures above 20°C, and reducing calcium increased the constant in the exponential equation of the mepp frequency increase. A model of the action of heat and calcium on receptor molecules is proposed.

55182 Involvement of brain gangliosides in temperature adaptation of fish. Breer, H.; Rahmann, H. (Univ., Stuttgart). *J. Therm. Biol.;* **1**: No. 4, 233-235(Oct 1976).

The ganglioside pattern of goldfish brain was investigated after adaptation (acclimatization, acclimation) to different temperatures. Adaptation at lower ambient temperature causes a higher proportion of polysialogangliosides to be formed in fish brain.

55183 Behavioral thermoregulation and neuroamines in fish (Chromus chromus). Green, M.D.; Lomax, P. (Univ. of California, Los Angeles). *J. Therm. Biol.;* **1**: No. 4, 237-240(Oct 1976).

A method for assessing the set temperature regulating behavioral thermoregulation in the fish Chromus chromus is described. Cholinergic stimulation of the brain, both muscarinic and nicotinic, lowered the thermoregulatory set point. Histamine raised the set temperature by an action on H_1-receptors. Increasing the brain catecholamines, with L-Dopa, also raised the set temperature but it was not possible to distinguish between dopaminergic or noradrenergic components of this response.

55184 Effect of temperature on the concentration of plasma gonadotropine and spermatogenesis of the goldfish Carassius auratus. Gillet, C.; Billard, R.; Breton, B. (Institut National de la Recherche Agronomique, Jouy-en-Josas, France). *Can. J. Zool.;* **55**: No. 1, 242-245(Jan 1977). (In French).

Concentrations of immunoreactive plasma gonadotropin (c-GtH) were measured for goldfish kept at conditions of temperature held constant or increasing between 10 and 30°C, between February and July. At temperatures of 17°C or above the levels of plasma c-GtH were significantly ($P < 0.005$) higher during April and May than at 10°C. In April the pituitary concentration of c-GtH was maximum for fish held at 17°C or above and the minimum for fish held below 17°C, but in June the situation was reversed. A study of the gonads showed that spermatogenesis is faster at 17—24°C than at 10°C, but at 30°C spermatogenic activity was inhibited.

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 53705

55185 (COO—2874-13) Scientific base for sulfur oxide air pollution standards. Goldstein, I.F. (Columbia Univ., New York (USA). Div. of Epidemiology). 1976. Contract EY-76-S-02-2874. 22p. (CONF-761174—1). MF A01.

From Conference on sulfur oxides; Cleveland, Ohio, United States of America (USA) (19 Nov 1976).

The main deficiencies in our existing scientific data base that make the formulation of air quality standards a difficult task are summarized. It is pointed out that there are a large number of pollutants in the air, most of which are not measured, many of which are not even identified, let alone tested for toxicity on animals. These pollutants interact in the atmosphere and in the body. Some of them act as co-factors for biological reactions; others have synergistic effects. Our measurements of pollutants are known to be of limited precision and accuracy: The representativeness of our measurements in terms of population exposures has not been adequately investigated. Suitable methods of controlling for other factors that might confound the relationship between pollution and health, such as weather, urbanicity, demographic factors, etc., have not been adequately tested.

55186 Analysis of biological materials for lead using atomic absorption spectroscopy. Coughtrey, P.J.; Martin, M.H. *Chemosphere;* **5**: No. 3, 183-186(1976).

Atomic Absorption Spectroscopy (AAS) has been the method commonly used in studies on the distribution and toxicity of lead within the ecosystem. The method was cheap, rapid, efficient and assumed to lack interference effects. Levels of Pb, Zn, Cd and Cu were determined within certain components of ecosystems. AAS methods were tested for their accuracy in the analysis of lead within complex matrices including high levels of calcium. Solutions of calcium carbonate in solutions of lead within a 20% nitric acid medium were prepared so as to contain Pb : Ca ratios of 1 : 100 to 1 : 50,000. Analysis of these solutions showed that interference with the lead reading occurs in test solutions. The lead reading is variously enhanced or depressed in relation to the machine parameter of flame composition and analytical wavelengths as well as Pb : Ca ratios. The interference may not be limited entirely to the elements discussed. Any study of lead using AAS should be carefully designed to determine the effects of any interfering ions in the solutions under observation. (MU)

CELLS

55187 Mutagenic mechanism of 5-bromodeoxyuridine in Chinese hamster cells. Aebersold, P.M. (Univ. of California, Berkeley). *Mutat. Res.;* **36**: No. 3, 357-362(Sep 1976).

Resistance to 6-thioguanine was induced by 5-bromodeoxyuridine (BUdR) in synchronous Chinese hamster cells. The yield of mutant colonies was not proportional to the amount of BUdR incorporated into DNA; thus mutants were not due to mispairing of BUdR with BUdR during replication. Few mutants were induced until BUdR concentrations exceeded that of the intracellular thymidine triphosphate pool and mutant yield was depressed by addition of thymidine to the medium. These data suggest that BUdR exerts an allosteric effect on the DNA synthesizing system which renders it more error prone.

MICROORGANISMS

55188 Changes in flora of soil fungi following oil waste application. Llanos, C. (Royal Veterinary and Agricultural Univ., Copenhagen); Kjoeller, A. *Oikos;* **27**: No. 3, 377-382(1976).

The influence of oil application to soil showed an increase in numbers of colony forming units (CFU) as well as in length of mycelium of soil fungi. Further, the treatment favoured the growth of Graphium and Paecilomyces. These genera were almost absent in the control area, which obviously had a much richer and more

evenly distributed fungal flora. Utilization of crude oil and pure hydrocarbons by the dominating fungi was demonstrated in culture.

PLANTS

REFER ALSO TO CITATION(S) 55188

55189 Volatilization of mercury by algae. Ben-Bassat, D.; Mayer, A.M. (Hebrew Univ. of Jerusalem). *Physiol. Plant.;* 33: No. 2, 128-132(15 Feb 1975).

The presence of Chlorella cells in a medium containing $HgCl_2$ causes a rapid decrease of the mercury content in the algal suspension. The rate of decrease depends on the inoculum concentration. The presence of Hg in the medium induces a lag in the growth, whose length depends on the initial concentration of Hg and of the inoculum. Binding and/or uptake of mercury by the cells is not dependent on temperature. The mercury content per cell declines somewhat at the time at which the culture resumes growth at a rate similar to that of the controls without mercury.

55190 Activity changes in selected enzymes from soybean leaves following ozone exposure. Tingey, D.T.; Fites, R.C.; Wickliff, C. (Environmental Protection Agency, Corvallis, OR). *Physiol. Plant.;* 33: No. 4, 316-320(15 Apr 1975).

Soybeans [Glycine max (L.) Merr.] were harvested at various time periods after a 2-h exposure to either 0 or 0.5 μl/l ozone to determine the effects of ozone on selected enzymes. Carbohydrate metabolism was modified by a depression of glyceraldehyde 3-phosphate dehydrogenase and an activation of glucose 6-phosphate dehydrogenase. Ozone did not alter the levels of RNase, protease, acid phosphatase or esterase as might be expected if ozone enhanced leaf senescence. The activities of phenylalanine ammonia lyase, polyphenol oxidase and peroxidase were initially depressed and then stimulated following the ozone exposure. The reactions of soybeans to an acute ozone stress were more nearly akin to those elicited in response to other stresses than to the process of senescence.

55191 Effects of SO_2 on photosynthesis and nitrogen fixation. Haellgren, J.E.; Huss, K. (Univ. of Umea, Sweden). *Physiol. Plant.;* 34: No. 2, 171-176(15 Jun 1975).

Responses of photosynthesis and nitrogen fixation to $NaHSO_3$ (10^{-5} to 5×10^{-3} M) were investigated in the lichen Stereocaulon paschale (L.) Fr. and the blue-green alga Anabaena cylindrica Lemmermann. The treatments were performed in buffered media with varying pH (5.8 to 8.1) and light conditions (0 to 32 W x m^{-2}). The activities of the intact organisms were investigated, under the same environmental conditions, with ^{14}C liquid scintillation and acetylene reduction techniques respectively. The nitrogen fixation proved to be more susceptible than photosynthesis, in both organisms, and in all cases treatments at pH 5.8 were more inhibitory than at higher pH-values. Treatment with 5×10^{-4} M $NaHSO_3$ at pH 5.8 caused no reduction of photosynthesis in S. paschale, while the inhibition of nitrogen fixation was 97%. For A. cylindrica the corresponding values were 40% and 75% respectively. Short-time treatments of A. cylindrica showed that the nitrogen fixation was more rapidly affected than photosynthesis. The inhibition of nitrogenase activity and CO_2-fixation was smaller in the dark and increased at higher light intensities. Both processes showed a good capacity for recovery after removal of the $NaHSO_3$ solution. Also the clumping ability of A. cylindrica was disturbed by $NaHSO_3$ treatments.

55192 Regional and local variations in heavy metal concentrations of bryophytes in the northeastern United States. Groet, S.S. (Univ. of Connecticut, Storrs). *Oikos;* 27: No. 3, 445-456(1976).

Wide regional variations in the deposition of air-borne heavy metals in the northeastern USA were determined by analyzing Leucobryum glaucum (Hedw.) Angstr. ex Fr., and other mosses collected throughout the region for Pb, Cu, Cd, Cr, Ni, and Zn. Lead, Cu, Cr, and Ni concentrations were generally highest in the southern, more highly industrialized portions of New England. A trend of decreasing concentrations with increasing distance from New York City was found for all metals except Cd. Cadmium and Zn concentrations tended to increase with increasing altitude. Except for Zn, the average concentrations of all metals in samples from the northeastern USA were considerably higher than the near-natural levels found in samples from remote areas of Canada, suggesting that high levels of air-borne heavy metals are present in the atmosphere of the northeast. Based on Leucobryum glaucum data, metal deposition rates were determined for various areas within the northeastern USA. Average annual deposition rates for the northeast were 32.9 +- 2.3 mg Pb m^{-2}, 2.4 +- 0.2 mg Cu m^{-2}, 0.19 +- 0.01 mg Cd m^{-2}, 13.5 +- 0.7 mg Zn m^{-2}, 1.3 +- 0.1 mg Cr m^{-2}, and 2.3 +- 0.2 mg Ni m^{-2}.

55193 Uptake of minerals, particularly metals, by epiphytic Hypnum cupressiforme. Rasmussen, L.; Johnsen, I. (Univ. of Copenhagen). *Oikos;* 27: No. 3, 483-487(1976).

Samples of bulk precipitation, epiphytic moss (Hypnum cupressiforme Hedw.) and photophyte bark were analyzed for contents Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Na, Pb, S, V and Zn. These analyses were the basis for a compartment study of the mineral cycling in an epiphytic ecosystem. The conductivity, pH, buffer capacity and concentrations of Ca, K, Mg and Na of Fraxinus excelsior L. and Fagus silvatica L. bark were determined in the traditional way on bark powder suspensions and also in solutions in equilibrium with discs of bark surface. The relation between bark properties and input-output of chemical elements to the epiphytic bryophytes was discussed. The differences in the epiphytic vegetation on Fraxinus and Fagus were assumed not to have been determined by the observed differences between Fraxinus and Fagus in properties of the bark powder suspensions, as these were not reflected in the solutions in equilibrium with the bark surface. Comparisons with other Scandinavian investigations on heavy metal contents in epigeic moss were made, and it was concluded that the metal contents of epiphytic moss originate mainly from the atmosphere.

INVERTEBRATES

55194 Effects of copper on the coral-reef echinoid Echinometra mathaei. Heslinga, G.A. (Univ. of Guam, Agana). *Mar. Biol.;* 35: No. 2, 155-160(1976).

The effects of copper-enriched seawater on fertilization success, early cleavage, larval skeletal development, and survivorship of adults of the coral-reef echinoid Echinometra mathaei (de Blainville) were tested. Fifty percent reduction of fertilization success and cleavage success to the 8-cell stage occurred in 0.18 and 0.42 mg added Cu^{2+}/l, respectively. Adults had respective 48- and 96-h TL_{50} values of 0.54 and 0.30 mg/l. Larval skeletal development was suppressed in 0.02 mg/l. The latter process appears to be very sensitive and may be the most suitable for assessing effects of stress on this species.

VERTEBRATES

55195 (EPRI—201) Interactive effects of sulfuric acid mist and nitrogen dioxide on cynomolgus monkeys. Final report. Coate, W.; Busey, W.; Schoensisch, W.S. (Hazleton Labs. America, Inc., Vienna, Va.). Oct 1975. 64p. Dep. NTIS, PC A04/MF A01.

One hundred cynomolgus monkeys, 36 males and 45 females, were subdivided into nine groups of four males and five females each. Eight groups were exposed via inhalation, under dynamic conditions to nitrogen dioxide (NO_2), sulfuric acid mist (H_2SO_4), or to a binary combination of NO_2 and H_2SO_4 mist. A ninth group was exposed to filtered room air and served as controls. The exposures were approximately 22 hours per day, seven days a week, for 26 consecutive weeks. Two died during Weeks 12 and 21, respectively, but these deaths were not exposure-related. No compound-related effects were seen in the pulmonary function test results. Similarly, no exposure-related differences were seen in the hematological, serum chemical, and blood gas measurements. Organ weights and organ/body weight ratios did not reveal any consistent trends that could be related to the exposure conditions.

55196 Studies on chemically induced dominant lethality. II. Cytogenetic studies of MMS-induced dominant lethality in maturing dictyate mouse oocytes. Brewen, J.G.; Payne, H.S. (Oak Ridge National Lab., TN). *Mutat. Res.;* 37: 77-82(1976).

Young adult female mice were injected intravenously with either 50- or 100-mg/kg doses of methyl methanesulfonate. The females were superovulated and mated to untreated males at intervals ranging from 0.5 to 14.5 days after treatment. The fertilized ova were collected and cultured to the first cleavage mitosis, at which time the female chromosome complement was analyzed for structural chromosomal damage. Chromatid-type aberrations were observed, but at a much lower frequency than previously reported for treatment of post-meiotic male germ cells. The time after treatment at which chromosomal damage was observed and the frequency of affected cells agree, qualitatively, with existing dominant-lethal data derived from treatment of maturing oocytes. Parallel experiments in which metaphase I oocytes were analyzed indicate a lack of MMS-induced chromosomal damage in the meiotic stages. This observation is consistent with the suggestion that an intervening round of DNA synthesis is necessary for MMS-induced lesions to be translated into chromosomal damage. The low yield of chromosomal damage is consistent with the idea that maturing oocytes, unlike late spermatids and spermatozoa, are capable of performing macromolecular repair of premutational lesions.

55197 Pulmonary aryl hydrocarbon hydroxylase activity in inbred strains of mice. Kouri, R.E. (Microbiological Associates, Bethesda, MD); Rude, T.; Thomas, P.E.; Whitmire, C.E. *Chem.-Biol. Interact.;* 13: No. 3/4, 317-331(Jun 1976).

Pulmonary and hepatic levels of aryl hydrocarbon hydroxylase (AHH) were studied in inbred strains of mice following intratracheal (i.t.) instillation of 3-methylcholanthrene (MCA). I.t. instillation of 188 μg MCA in sterile 0.2 percent gelatin in saline resulted in preferential induction of pulmonary AHH. After treatment with this

dose of MCA, the pulmonary AHH levels of strains C57BL/6Cum, C 57BL/6J, BALB/ cMai, C3H/fMai, and C57L/J were observed to be induced within 24 h after treatment. Strains DBA/2Cum, AKR/J, SJL/J, DBA/2J and RF/J expressed no such increase. At a dose of 500 μg MCA, the pulmonary tissue of DBA/2 mice did express a 4-fold increase. This increase in AHH was determined to be quite different from the increase observed in C57BL/6 mice by: (1) specific activity of the enzymes, (2) genetic regulation, (3) susceptibility to inhibition by 7,8-benzoflavone, and (4) spectral properties of the associated cytochromes. It was of major importance that induction of pulmonary AHH was observed to be regulated by a single dominant gene in crosses involving the C57BL/6Cum and DBA/2Cum strains of mice. Results were discussed with the view in mind that these genetically regulated levels of AHH may play a role in susceptibility to cancers induced by polycyclic aromatic hydrocarbon carcinogens.

55198 Surface preparation study on the effect of methyl mercury on the sensory hair cell population in the cochlea of the harp seal (Pagophilus groenlandicus Erxleben, 1777). Ramprashad, F.; Ronald, K. (Univ. of Guelph, Ont.). *Can. J. Zool.;* 55: No. 1, 223-230(Jan 1977).

Surface preparations of the organ of Corti of four harp seals were used to study the effect of prolonged ingestion of methyl mercury on the sensory cell population. A low level of damage to the sensory hair cells occurred throughout the length of the cochlea. Damage was confined to the three outer rows of sensory hair cells especially the third outermost row. At each location along the length of the cochlea, sensory hair cell damage in the seals on a daily dose of 25.0 mg/kg of methyl mercury exceeded the damage to the cochlea of the seals fed on a daily dose of 0.25 mg/kg of methyl mercury. Greatest damage in all the mercury-treated seals occurred in the middle coil of the cochlea. Seals on the higher mercury diet showed a 20 to 24 percent sensory cell damage at the upper middle coil, about 19 to 26 mm from the base, whereas only 4 to 5 percent damage was found within same region in the cochlea of the seals on the lower mercury diet. This lack of specificity and low level of damage to the sensory hair cells seems characteristic of mercury and is a direct contrast to other known ototoxic agents.

MAN

55199 (ORNL/TIRC—77/2) **Methoxyflurane: I. An overview. II. An abstracted literature collection, 1947—1976.** Waters, E.M.; Ricci, B.E. (Toxicology Information Response Center, Oak Ridge, Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 120p. Dep. NTIS, PC A99/MF A01.

Evidence presented in the literature suggests that methoxyflurane (Penthrane) (MOF) is a potent and efficacious anesthetic. At the same time, however, observed adverse reactions indicate that additional data are needed to determine the feasibility for continued widespread use of MOF. Experimental and clinical evidence clearly demonstrates that the ionic metabolites of MOF (fluoride and oxalate ions) are the toxic moieties responsible for the resultant physiologic maladies. This report on methoxyflurane is comprised of an overview and an abstracted literature collection.

55200 Nature of the product which results when 7,8-dihydro-7,8-dihydroxybenzo(a)pyrene is metabolised in vitro and bound to DNA. King, H.W.S.; Thompson, M.H.; Tarmy, E.M.; Brookes, P.; Harvey, R.G. (Inst. of Cancer Research, Chalfont St. Giles, Eng.). *Chem.-Biol. Interact.;* 13: No. 3/4, 349-352(Jun 1976).

The product which arises from metabolism of BP-7,8-diol by microsomes in the presence of DNA is examined. The results of the experiment confirmed that when BP-7,8-diol is metabolized by isolated microsomes a particularly reactive intermediate results. Also, a subsequent reaction with DNA occurs on the purines elsewhere than at carbon-8 and the product appears to be a derivative of 7, 8, 9, 10-tetrahydro-BP. (CAJ)

55201 Reaction of 7,8-dihydro-7,8-dihydroxybenzo(a)pyrene-9,10-oxide with DNA in relation to the benzo(a)pyrene-DNA products isolated from cells. Osborne, M.R. (Inst. of Cancer Research, Chalfont St. Giles, Eng.); Thompson, M.H.; Tarmy, E.M.; Beland, F.A.; Harvey, R.G.; Brookes, P. *Chem.-Biol. Interact.;* 13: No. 3/4, 343-348(Jun 1976).

Evidence is presented that the in vivo product formed when BP is bound to the DNA of cells in culture derives from BP-diolepoxide. The reaction with DNA of the two geometrical isomers of BP-diolegoxide was studied. (CAJ)

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

REFER ALSO TO CITATION(S) 55069

55202 (AD-A—039033) **Research on the ocular effects of laser radiation. Report No. 1 (annual) 15 Feb 73—15 Feb 74.** Sanders, V.E.; Zuclich, J.A. (Technology, Inc., San Antonio, Tex. (USA). Life Sciences Div.). 15 Feb 1974. Contract F41609-73-C-0017. 127p. (TI—74-0561-01). NTIS PCA07/MF A01.

This report is divided into two parts, both of which are concerned with research on the ocular hazards of laser irradiation. Part I deals with radiation in the visible wavelength range. It contains: a completed study on the size of retinal lesions induced by laser light as a function of the laser beam parameters; a study, partially complete, of the wavelength dependence of threshold retinal damage; two studies in progress on histological results; and an appendix on laser beam retinal spot size in the emmetropic eye. Part II deals with ocular hazards from ultraviolet (UV) laser irradiation. It contains: a summary of literature surveys on absorption characteristics and molecular composition of components of the eye; and development of a preliminary quantitative model relating the extent of photochemical damage to laser beam characteristics.

55203 (AD-A—039034) **Research on the ocular effects of laser radiation. Report No. 2 (annual) 16 Feb 74—15 Feb 75.** Connolly, J.S.; Zuclich, J.A.; Nawrocki, A.D.; Hemstreet, H.W.; Sanders, V.E. (Technology, Inc., San Antonio, Tex. (USA). Life Sciences Div.). 15 Feb 1975. Contract F41609-73-C-0017. 150p. (TI—75-0561-02). NTIS PCA07/MF A01.

This second annual report summarizes research on ocular effects of radiation in five distinct but inter-related research areas. The first deals with experimental verification of theoretical predictions on effects of ocular blood flow on laser-induced retinal burn thresholds. The second major research effort is concerned with ocular effects of UV laser radiation in the cornea and lens. Continous wave output from a krypton-ion laser (350.7 and 356.4 nm) produces corneal lesions. The third research project involves in situ microprobe measurements of laser-induced retinal temperatures in living primates. The fourth part of this report summarizes histological investigations conducted in support of research on ocular effects of laser radiation. Part five of this report summarizes the final results of experiments under-taken to determine the effect of wavelength on retinal damage thresholds induced by laser radiation in the visible region.

55204 (PB—265614) **The national measurement system for medical ultrasonics.** Hudson, P.A. (National Bureau of Standards, Boulder, Colo. (USA)). Feb 1976. 21p. (NBSIR—75-937). NTIS PCA02/MF A01.

The rapid increase in the use of ultrasonics in medical diagnostics has been brought about by recent advances in imaging techniques employing sophisticated electronic systems. Along with the proliferation of this equipment in the medical community has come concern about possible tissue damage due to this type of radiation. Research on damage thresholds is being carried out in laboratories across this country and overseas. Agreement between various researchers is hampered by lack of accurate standards for measurement of transducer beam power and intensity. The National Measurement System for medical ultrasonics is, at this time, inadequate, fragmented and largely uncoordinated. The Electromagnetics Division is in process of developing standards for measurement of transducer beam power, intensity, and beam pattern. These standards will be disseminated widely throughout the country to provide the needed accuracy and measurement agreement among biomedical researchers and ultimate users (hospitals, physicians, clinics, etc.).

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 55110

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 53725, 53743, 53840, 53936, 53997

GEOPHYSICS

MAGMATISM, VOLCANOLOGY, AND IGNEOUS PROCESSES

55205 Magma mixing: a mechanism for triggering acid explosive eruptions. Sparks, S.R.J. (Univ. of Rhode Island, Kingston); Sigurdsson, H.; Wilson, L. *Nature (London);* 267: No. 5609, 315-318(26 May 1977).

Inspection of basic magma into acid magma causes superheating of the acid magma and vigorous convection. Vesiculation induced by convection and increased magma pressure fractures the volcanic edifice triggering an explosive acid eruption. The 1875 plinian eruption of Askja, Iceland is an example of an explosive eruption tirggered by magma mixing.

GEOPHYSICAL SURVEY METHODS

REFER ALSO TO CITATION(S) 53721

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 53989

55206 (TID—27652) **Dynamic reflective photoelasticity study of rock fracture mechanisms. Final report, December 1, 1974—December 31, 1975.** (West Virginia Univ., Morgantown (USA). Dept. of Mechanical Engineering and Mechanics). Jan 1976. 84p. Dep. NTIS, PC A05/MF A01.

This study is part of a hydraulic fracturing research program for improving oil and gas recovery techniques. The study is aimed at making the hydrofracture patterns to intersect the direction of preferential porosity. Results show that semi-infinite plate theory and finite element modeling can be applied to large grain sized, oil-bearing sandstone with varying success. Conventional strain gaging techniques can be successfully applied to sandstone if precautions are taken. A dependable stress analysis technique in a high strain gradient area is needed; reflective photoelasticity has excellent capability, but no available photoelastic coating is sensitive enough to respond to the low strain levels at which sandstone fractures. Recommendations are given for further investigation. 25 figures, 9 tables. (DLC)

55207 **Constitutive relation describing dilatant behavior in climax stock granodiorite.** Schock, R.N. (Univ. of California, Livermore). *Int. J. Rock Mech. Min. Sci. Geomech. Abstr.;* **13**: 221-223(1976).

Climax Stock granodiorite was compressively loaded along different paths to failure at a fixed strain rate and at mean pressures to 0.7 GPa. These data are used to develop a constitutive relation. The expression relates dilatant volume strain epsilon/sub d/ to mean pressure P and shear stress tau in the form epsilon/sub d/ = exp[(delta P)/x(tau) - A(tau)], where x and A are explicit functions of tau. The equation has the advantage of simplicity and of expressing the actual behavior in terms of measured physical parameters.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 53743, 53989, 54008

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

STARS

55208 **Mass transfer in semi-detached binaries.** Shu, F.H. (California Univ., Berkeley (USA)). pp 253-264 of In Structure and evolution of close binary systems. Eggleton, P.; Mitton, S.; Whelan, J. (eds.). Dordrecht, The Netherlands; D. Reidel (1976).

From International Astronomical Union symposium no. 73 on structure and evolution of close binary systems; Cambridge, UK (28 Jul - 1 Aug 1975).

The dynamics of gas streams in semi-detached binaries is reviewed from the standpoint of the theory of matched asymptotic expansions. Physical concepts are emphasized and some astronomical applications are considered. The model of impact-driven accretion disks is also discussed briefly.

55209 **Thermal phase of the carbon-burning flash in a degenerate carbon—oxygen stellar core.** Ergma, E.V.; Kudryashov, A.D.; Shchervbatyuk, V.A. (Astronomical Council, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 5, 557-562(Sep 1976).

The thermal phase of carbon burning is investigated in carbon—oxygen and pure carbon cores, with allowance for heat conduction by degenerate relativistic electrons and for convection (in the mixing-length approximation, including a rough correction for time dependence). For maximum efficiency of convective energy transfer, the temperature rise occurs in the region corresponding to the five central mass zones. The results of the calculation indicate that the subsequent hydrodynamic outburst as a supernova will take place in the form of pulsational instability of the star, and will proceed in a deflagration regime.

55210 **Supernova models with gradual energy release.** Nadezhin, D.K.; Utrobin, V.P. (Institute of Applied Mathematics, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 5, 562-570(Sep 1976).

Supernova models assuming a gradual (nonexplosive) injection of energy into an internal spherical layer have been calculated. The star has a total mass of 1.7 M/sub sun/; the ejected envelope 0.4 M/sub sun/; and the chemical composition is pure helium. An energy release in the range (0.3—1) $x10^{51}$ erg is considered, and a radius of 1—1000 R/sub sun/ for the presupernova; the corresponding envelope expansion velocity is (6—$18x10^3$ km/sec. At bolometric maximum the envelope has the form of a thin spherical shell several solar radii thick, while the radius of the photosphere is of order 10^4 R/sub sun/. The density of the shell at this stage is 10^{-10} g/cm^3 and the temperature is $2x10^{40}$K, so that helium is singly ionized. The shell should be highly turbulent because of convection and Rayleigh-Taylor instability. Light curves have been calculated and are qualitatively consistent with observations of type I supernovae near maximum light. For a compact model presupernova, only a slow injection of energy over a period of 2—20 days can yield light curves fitting the observations. On the other hand, explosive energy release would call for an extended envelope around the presupernova.

55211 **Mechanism of energy release in a degenerate nuclear plasma.** Vartanyan, Y.L.; Ovakimova, N.K. (Erevan State University). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 5, 643-644(Sep 1976).

It is shown that the cool evaporation of neutrons from nuclei in a degenerate electron-neutron plasma occurs in nonequilibrium. The energy of the neutrons which have separated from the nuclei proves to be higher than the Fermi energy of the external degenerate neutron gas. This additional energy can heat the matter up to 10^9degreeK.

55212 **γyields$\nu\nu$-bar and νyields$\gamma\nu$ reactions in strong magnetic fields.** Skobelev, V.V. (Moscow Institution of Geodesy, Aerial-Photography, and Cartography Engineers). *Sov. Phys. - JETP (Engl. Transl.);* **44**: No. 4, 660-662(Oct 1976).

The γyieldsνnu-bar and νyields$\gamma\nu$ decay probabilities in a strong magnetic field are found by employing an effectively two-dimensional representation of the electron Green's function. The contribution of the γyieldsνnu-bar photodecay to the neutrino luminosity of pulsars is estimated. The contributions of other diagrams with vacuum loops are discussed. Previous results obtained in the frequency range ωvery-much-greater-thanm, in which the crossed-field approximation is valid, are confirmed. In fields $\sim 10^{16}$ G the γyieldsνnu-bar process competes with the n+nyieldsn+p+e$^-$+nu-bar reaction, so that vacuum polarization effects may influence the cooling of neutron stars in their initial evolution stage.

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

55213 **Ellipsoidality effects and linear polarization in close x-ray binaries.** Gnedin, Y.N.; Silant'ev, N.A.; Shibanov, Y.A. (Ioffe Physics and Technology Institute, USSR Academy of Sciences, Leningrad). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 5, 530-535(Sep 1976).

The phase dependence of the Stokes parameters and the percentage linear polarization for the optical component of an x-ray binary system is calculated for several values of the ellipsoidality of that component and the inclination of the orbit plane. A strong hot spot on the surface of the ellipsoidal star will produce a complicated polarization phase dependence. A situation can arise where the polarization changes sign four times in one period. The percentage polarization of an accretion envelope is calculated for various thickness/radius ratios. A comparison with polarimetry of the Cyg X-1 system (HDE 226868) indicates that the ellipsoidal star should have an axial ratio of at least 0.85.

55214 **Role of the Alfven surface in forming x-ray pulses in accreting pulsars.** Basko, M.M.; Syunyaev, R.A. (Institute for Space Research, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 5, 537-540(Sep 1976).

A straightforward analysis of the observational evidence shows that the pulsations in the x-ray flux from the sources Her X-1 and Cen X-3 cannot be explained unless one invokes a special mechanism to generate pulses of the shape observed. In the event of disk accretion onto a magnetized neutron star, the plasma layer flowing along the Alfven surface and spinning together with the star will regularly shield from the observer the bright spots at the magnetic poles where the energy of the infalling gas is released. This effect will produce pulsations in the hard x-ray flux observed. The plasma layer on the Alfven surface will be a source of soft x rays, which should also pulsate weakly.

55215 **Velocities of pulsars.** Lotova, N.A.; Chashei, I.V.; Shabanova, T.V. (Lebedev Physics Institute, USSR Academy of Sci-

ences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* 20: No. 5, 541-543(Sep 1976).

Estimates of pulsar velocities obtained by various measurement techniques are compared. The small values derived from the drift velocity of the scintillation diffraction pattern are much too low because of the reduction procedure used, and are not trustworthy. There is no reliable evidence for low pulsar velocities $v<100$ km/sec.

55216 Nuclear-energy release in neutron-star envelopes, and sources of x-ray emission. Bisnovatyi-Kogan, G.S.; Kulikov, Y.N.; Chechetkin, V.M. (Institute for Space Research, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* 20: No. 5, 552-556(Sep 1976).

As a hot neutron star evolves, an envelope with a nonequilibrium chemical composition will be formed. Subsequently the envelope will decay and the nuclear energy stored in it may be radiated. The decay of the nonequilibrium layer will be caused by diffusion of neutrons toward the center of the neutron star in its gravity field. Diffusion equations for a plane layer are considered. The equations are solved numerically by computer, and the luminosity, chemical composition, and structure of the envelope are determined as functions of time. The nuclear energy stored in the envelope will be adequate to support an x-ray luminosity of the neutron star at a level of 10^{34}—10^{36} erg/sec for 10^4 yr. The relation of the model to observed x-ray sources and pulsars is discussed. This model is especially pertinent to the nucleosynthesis of heavy elements ($A<60$); only 10^9 neutron stars throughout the Galaxy would be needed to account for the formation of these elements. Some possible observational implications of the model are outlined.

SOLAR PHENOMENA

55217 (AD-A—038124) Ephemeral active regions during the solar minimum. I. General properties and trends over the solar cycle. II. Characteristics of individual ephemeral regions. Final report 1 Oct 75-30 Sep 76. Martin, S.F.; Harvey, K.L. (Spectra Optics, Sylmar, Calif. (USA)). 28 Dec 1976. Contract F19628-76-C-0081. 58p. NTIS, PC A04/MF A01.

General properties of ephemeral active regions were studied using Kitt Peak daily magnetograms from Apr.-Nov. 1975. Although this interval was prior to sunspot minimum, ephemeral regions related to incoming cycle 21 were already more numerous than ephemeral regions related to outgoing cycle 20. The transition between the old and new solar cycle was identified by a reversal of the statistically dominant orientation of regions and sometimes by a minimum in the latitude distribution where adjacent cycles overlapped. During this interval the transition between cycle 20 and 21 was at N18 deg and S24 deg. Comparing this 1975 data with previously studied data from 1970 and 1973, we find evidence that incoming cycle 21 was already present on the sun at middle and high latitudes in 1973 and 1970. Extrapolating backward and forward in time from these three periods, we find that it is conceivable that two solar cycles may be present on the sun at all times. It appears that further statistical studies of ephemeral active regions may yield long-term prognostic information on the future course of solar activity. The birth of 90 ephemeral regions was recorded. Prior to the birth of regions, existing network was found to disappear or show lateral displacement. The growth and decay rates of regions were comparable. In the decaying phase, some flux elements simply disappeared; some merged with network or other elements of regions of similar polarity; some collided and simultaneously disappeared with network or elements of other regions of opposite polarity. All clearly identifiable ephemeral regions dissipated by these processes while continuing to expand.

55218 (AD-A—038534) A spectral atlas of the Sun between 1175 and 2100 angstroms. Final report. Moe, O.K.; Van Hoosier, M.E.; Bartoe, J.D.F.; Brueckner, G.E. (Naval Research Lab., Washington, D.C. (USA)). 31 Dec 1976. 62p. (NRL—8056). NTIS PCA04/MF A01.

This atlas provides solar spectra with high spectral resolution which will satisfy the needs of both solar physics and aeronomy for information on the solar spectrum in the wavelength range 1175 to 2100 angstroms. The spectra may furthermore be useful for comparison with stellar UV spectra and with the red shifted spectra of quasars. Specific intensities as functions of wavelength are shown for two quiet regions between 1175 and 2100 angstroms and for one active region between 1680 and 2100 angstroms. The two quiet regions, located at heliocentric positions cos theta = 0.73 and cos theta = 0.32, represent a disk and a limb spectrum of the Sun. The absolute intensities are determined with an accuracy of +- 25% and the wavelength scale is accurate to 0.025 angstroms. The spectral resolution is 0.07 angstroms.

55219 (AD-A—038782) Polarization spectra of centimeter wavelength solar bursts using whole-Sun observations. Environmental research paper. Guidice, D.A. (Air Force Geophysics Lab., Hanscom AFB, Mass. (USA)). 8 Dec 1976. 36p. (AFGL-TR—76-0295;AFGL-ERP—585). NTIS PCA03/MF A01.

The physics of microwave-burst emission is briefly examined to give the rationale for investigating polarization spectra. The instruments used to carry out the 9.4 GHz and 7 GHz circular-polarization measurements and the 5 GHz Stokes-parameter measurements are described. A survey of the August 1972 to December 1973 period produced a table of 45 bursts, from which some limited results were obtained. About 75 to 80 percent of all bursts are circularly polarized, with varying polarization over the 5 to 9.4 GHz range. For most bursts where the circular polarization pc increases toward the upper or lower end of the 5 to 9.4 GHz range, the total intensity I also increases in that direction. The few bursts having a pc sense reversal in the 5 to 9.4 GHz range also have a spectral maximum of I at roughly the same frequency. Some simplified explanations of the results are presented.

55220 (AD-A—038822) Stereoscopic direction finding analysis of a type III solar radio burst: evidence for emission at twice the plasma frequency. Progress report. Gurnett, D.A.; Baumback, M.M.; Rosenbauer, H. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy). Apr 1977. Contracts N00014-76-C-0016;NAS5-11431. 41p. (U-OF-IOWA—77-13). NTIS PCA03/MF A01.

Stereoscopic direction finding measurements from the IMP 8, Hawkeye 1 and Helios 2 spacecraft over baseline distances of a substantial fraction of an A.U. are used to directly determine the three-dimensional trajectory of a type III solar radio burst. By comparing the observed source positions with the direct solar wind plasma density measurements obtained in situ by Helios 1 and 2 near the sun the relationship of the emission frequency to the local plasma frequency can be determined directly without any modeling assumptions. These comparisons show that the type III radio emission occurs near the second harmonic of the local electron plasma frequency. Other characteristics of the type III radio emission, such as the source size, which can be obtained from this type of analysis are also discussed.

55221 (AD-A—039092) Ion-acoustic waves in the solar wind. Progress report. Gurnett, D.A.; Frank, L.A. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy). Mar 1977. Contracts N00014-76-C-0016;NAS5-11279. 66p. (U-OF-IOWA—77-10). NTIS PCA04/MF A01.

Plasma wave measurements on the Helios 1 and 2 spacecraft have revealed the occurrence of electric field turbulence in the solar wind at frequencies between the electron and ion plasma frequencies. Wavelength measurements with the IMP 6 spacecraft now provide strong evidence that these waves are short wavelength ion-acoustic waves which are Doppler shifted upward in frequency by the motion of the solar wind. Comparison of the Helios results with measurements from the earth-orbiting IMP 6 and 8 spacecraft shows that the ion-acoustic wave turbulence detected in interplanetary space has characteristics essentially identical to bursts of electrostatic turbulence generated by protons streaming into the solar wind from the earth's bow shock. In a few cases enhanced ion-acoustic wave intensities have been observed in direct association with abrupt increases in the anisotropy of the solar wind electron distribution. This relationship strongly suggests that the ion-acoustic waves detected by Helios far from the earth are produced by an electron heat flux instability, as suggested by Forslund. Possible related mechanisms which could explain the generation of ion-acoustic waves by protons streaming into the solar wind from the earth's bow shock are also considered.

55222 (N—77—17986) The 15 June 1973 1B/M3 flare: an overview of analysis results. Wilson, R.M. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). Dec 1976. 18p. (NASA-TM-X—73357). NTIS, PC A02/MF A01.

The 15 June 1973 1B/M3 flare was analyzed as one of the best observed flares during the skylab mission.

55223 (N—77—17988) Skylab ATM/S-056 x-ray event analyzer observations versus solar flare activity: an event compilation. Wilson, R.M. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). Jan 1977. 86p. (NASA-TM-X—73363). NTIS, PC A05/MF A01.

An event compilation is presented which correlates ATM/S-056 X-ray event analyzer solar observations with solar flare activity. Approximately 1,070 h of pulse height analyzed X-ray proportional counter data were obtained with the X-ray event analyzer during Skylab. During its operation, 449 flares (including 343 flare peaks) were observed. Seventy events of peak X-ray emission were simultaneously observed by ground based telescopes, SOLRAD 9 and/or Vela, and the X-ray event analyzer. These events were observed from preflare through flare rise to peak and through flare decline.

55224 (N—77—17993) A long-lived coronal x-ray arcade. Mcguire, J.P.; Tandberg-hanssen, E.; Krall, K.R.; Wu, S.T.; Smith, J.B. Jr. (National Aeronautics and Space Administration, Huntsville,

Ala. (USA). George C. Marshall Space Flight Center). Jan 1977. Contract NAS8-28097. 24p. (NASA-TM-X—73362). NTIS, PC A02/MF A01.

Subm-Sponsored in Part by Noaa.

A large, long-lived, soft X-ray emitting arch system observed during a Skylab mission is analyzed. The supposition is that these arches owe their stability to the stable coronal magnetic-field configuration. A global constant alpha force-free magnetic field analysis is used to describe the arches which stayed in the same approximate position for several solar rotations. A marked resemblance is noted between the theoretical magnetic field configuration and the observed X-ray emitting feature.

55225 (PB—265761) **The three dimensional solar corona. a coronal streamer. Doctoral thesis.** Wilson, D.C. (National Center for Atmospheric Research, Boulder, Colo. (USA)). 1977. Contract NSF-C760. 292p. (NCAR-CT—40). NTIS, PC A13/MF A01.

The first derivation of the 3-D electron density of a coronal streamer is presented and interpreted in terms of streamer magnetic fields and solar wind flow. An algebraic reconstruction technique is modified to reconstruct densities from K-coronal observations, and its resolution and reliability are explored. A single streamer was studied. In photographs it had the helmet structure often used to infer a circular cross section, but reconstruction showed it to be extended along the line of sight. Cross sectional area, increasing as r/ sup 1./, showed no minimum at the least apparent width. Average streamer density followed the Newkirk (1967) equatorial density model, with lower densities above 2 RO than in earlier models. This decrease may be typical of all streamers. Comparison with magnetograms, X-ray photographs, and potential fields showed bipolar field but highest densities outside the neutral sheet. Application of fluid equations to streamer flow showed a subsonic velocity below 6 RO. The derived temperature profile agreed with other measurements, including type III burst determinations, and confirmed theoretical models of streamer solar wind. There is evidence for extended heating.

55226 Microstructure in continuous emission of type IV meter bursts. Modulation of continuous emission by wave packets of whistlers. Chernov, G.P. (Institute of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, USSR Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 5, 582-589(Sep 1976).

The dynamic spectra of the microstructure in emission and absorption in the event of July 3, 1974, and a possible model of the emission source were discussed in the first part of the report {G. P. Chernov, Astron. Zh. 53, 798 (1976) [Sov. Astron. 20, 000 (1976)]}. In the second part the emission of this microstructure is interpreted as the nonlinear interaction of Langmuir oscillations with wave packets of whistlers. The possibility of the generation of packets of whistlers and their reflection at the lower hybrid frequency during propagation in a source of the magnetic trap type is discussed. A band of enhanced emission is formed in the confluence at sum frequencies, while the emission is suppressed at frequencies encompassed by the whistlers. In this case the radiation must be strongly polarized and of the ordinary type. Frequency profiles of the bands in emission and absorption are calculated which agree with the observed profiles.

55227 Pulsed solar microwave bursts with a quasithermal spectrum. Uralov, A.M.; Nefed'ev, V.P. (Siberian Institute of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Siberian Branch of the Academy of Sciences of the USSR). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 5, 590-592(Sep 1976).

The heat released in a chromospheric flare is carried upward by a shock (or thermal) wave. A radio burst is formed when the leading front of the hot expanding region reaches optical depths on the order of unity. Absorption due to free-free transitions is assumed to be dominant.

55228 Magnetic pumping of energy into a nonequilibrium turbulent plasma as a possible energy source in solar flares. Sinitsyn, Y.A.; Pimenov, S.F. (Institute of Radio Physics and Electronics, Academy of Sciences of the Ukrainian SSR). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 5, 596-600(Sep 1976).

The dissipation of the energy of an external slowly varying magnetic field into a nonequilibrium (Kolmogorov) turbulent plasma is analyzed. It is shown that the field energy is absorbed considerably faster than in the case of an equilibrium system of plasmons. The proposed mechanism can be very important under the conditions of solar flares.

GALAXIES

55229 Near-infrared pumping of H_2O maser sources. Shmeld, I.K. (Radio Astrophysical Laboratory, Latvian Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 5, 571-573(Sep 1976).

The interaction of H_2O molecules with near-infrared radiation in the ν_2, ν_3 vibrational bands under the conditions of an interstellar molecular cloud is calculated. Only for a narrow (and therefore improbable) range of physical conditions will such an interaction invert the 6_{16}—5_{23} transition. Near-infrared radiation accordingly cannot be the main factor responsible for pumping cosmic H_2O masers.

55230 Profile of the Hnα radio lines in a static ion field. Gulyaev, S.A. (Gor'kii University of the Urals). *Sov. Astron. AJ (Engl. Transl.);* **20**: No. 5, 573-576(Sep 1976).

The Gordon expression for the coordinate matrix elements in parabolic coordinates simplifies considerably for large values of the principal quantum number n. If the Stark components of the Hnα line are grouped into series, the shape of the envelope for quasistatic splitting of the line in the electric field of plasma ions can be calculated. In this manner a halfwidth one-third that customarily used in the quasistatic approximation is obtained.

55231 Analogy between the formation of spiral arms of galaxies and density waves in a rotating laboratory plasma. Morozov, A.G.; Fainshtein, V.G.; Fridman, A.M. (Institute of Terrestrial Magnetism, the Ionosphere, and the Propagation of Radio Waves, Siberian Branch, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **44**: No. 4, 653-660(Oct 1976).

The possibility of analogy between the formation of the spiral structure of galaxies and density waves in a rotating laboratory plasma is discussed. It is shown in different examples that in gravitating systems one can have a Kelvin—Helmholtz instability and a flute instability with growth rates much larger than the Jeans growth rate. Under certain conditions, the growth rates of these instabilities are equal to the growth rates of the corresponding plasma instabilities.

55232 Local interstellar helium density. Freeman, J.; Paresce, F.; Bowyer, S.; Lampton, M.; Stern, R.; Margon, B. (Space Sciences Laboratory, University of California, Berkeley). *Astrophys. J., Lett.;* **215**: No. 2, L83-L86(15 Jul 1977).

During the Apollo-Soyuz Test Project, an extreme-ultraviolet telescope observed the region of the sky from which the interstellar medium approaches the Sun. The instrument had a tin filter whose bandpass included the 584 A line of neutral helium. The observations set an upper bound for the number density of neutral helium in the local interstellar medium of 0.004 +- 0.0022 cm^{-3}, which is significantly lower than previously reported. The stated error is dominated by the present uncertainty in the solar 584 A flux, which we have taken to be (20 +- 10) x 10^8 photons cm^{-2} s^{-1} at the Earth's orbit. Our result is not consistent with previous resonant-scattering Lα observations of interstellar hydrogen passing through the solar system, which generally yield n/sub H/ ~0.1 cm^{-3}, unless interstellar helium is locally depleted below its cosmic abundance. The result is consistent with cosmic abundances if the much lower average hydrogen densities inferred from recent column density measurements to nearby hot stars are in fact representative of the immediate solar neighborhood.

COSMOLOGY

55233 Possibility of a cold cosmological singularity in the spectrum of primordial black holes. Zel'dovich, Y.B.; Starobinskii, A.A. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **24**: No. 11, 571-573(5 Dec 1976).

We consider entropy generation accompanying evaporation of primordial black holes. Bounds are obtained on the number of black holes with mass $M < 10^{13}$ g. It is shown that the initial cold matter, when transformed halfway into black holes with $M \sim 10^4$ g, acquires the presently observable entropy after the black-hole evaporation.

PLANETARY PHENOMENA

55234 Elimination of ^{240}Cm as a possible progenitor of carbonaceous chondrite fission xenon. Leich, D.A.; Niemeyer, S. (California Univ., Berkeley (USA). Dept. of Physics); Michel, M.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Earth Planet. Sci. Lett.;* **34**: No. 2, 197-208(2 Mar 1977).

Spontaneous fission of ^{248}Cm may be responsible, at least in part, for the heavy-isotope anomalies, known as the CCF component, in xenon extracted from carbonaceous chondrites. In order to test this hypothesis, the isotopic spectrum of xenon fission products from a 97% isotopically pure ^{248}Cm sample was measured. The products of spontaneous fission of ^{248}Cm were found to be mixed with the products of heavy-ion-induced fission reactions. The latter component was produced in a prior use of the ^{248}Cm sample as a target for a heavy-element synthesis experiment. Fortunately, the induced fission component accounts for only approximately 10% of the observed Xe yields, and its composition can be estimated sufficiently well to allow a fairly precise determination of the isotopic composition of Xe from spontaneous fission of ^{248}Cm. The data also allow two other estimates of the spontaneous fission yields, free of the induced fission component. After fairly large corrections for incomplete decay of precursors to ^{131}Xe and ^{132}Xe, these indepen-

dent estimates of the spontaneous fission yields are in reasonable agreement with the estimates based on the initial outgassing of the sample, corrected as described for the induced fission component. The best estimate of the composition of Xe from spontaneous fission of ^{248}Cm is as follows: $^{134}Xe/^{136}Xe = 1.065 +- 0.015$, $^{132}Xe/^{136}Xe = 0.81 +- 0.03$ and $^{131}Xe/^{136}Xe = 0.49 +- 0.06$. These results are totally inconsistent with any of the various estimates of the CCF composition, implying that if spontaneous fission of ^{248}Cm contributed at all to the CCF component, the contribution was relatively minor.

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

55235 (AD-A—038532) **Simulation of leading edges of backscatter ionograms for ionospheric inference.** Wong, M.S. (Rome Air Development Center, Griffiss AFB, N.Y. (USA)). Nov 1976. 23p. (RADC-TR—76-354). NTIS PCA02/MF A01.

Jones' ray-tracing program and integrated subroutines by Langworthy and Barrett are being used to compute swept-frequency ionograms, for backscatter by ground and field-aligned ionization, in the presence of sharp horizontal boundaries in electron-density distributions. Prominent characteristics, minimum group-path traces, ray-density variations, and off-great-circle deviation along ray paths are presented for various alterations on major features of initial electron distributions.

55236 (AD-A—038807) **Analysis of ground station magnetometer data obtained during the rocket launches in the AEOLUS program, April 1975, at Ft. Churchill, Manitoba. Final report Dec 75—Dec 76.** Hanser, F.A.; Sellers, B. (Panametrics, Inc., Waltham, Mass. (USA)). Dec 1976. Contract F19628-76-C-0121. 72p. NTIS PCA04/MF A01.

Magnetometer data from more than a dozen ground stations near the Ft. Churchill part of the Auroral Zone have been obtained and analyzed for the AEOLUS rocket launches in April 1975. The magnetically active launch of 10 April showed considerable activity starting to the west of, and moving into, the Ft. Churchill area. The quiet launch of 21 April showed little activity. The Auroral launch of 25 April was accompanied by magnetic activity, though not as intense as that of 10 April. Electrojet calculations show that conditions on 10 April were very promising for high altitude wave generation that might be observable in the chemical release data.

MAGNETOSPHERIC PHENOMENA

55237 (N—77—17326) **Characteristics of magnetospheric radio noise spectra. Final report, Dec. 1974 - Dec. 1975.** Herman, J.R. (Radio Sciences Co., Lowell, Mass. (USA)). 22 Jan 1976. Contract NAS5-20807. 83p. (NASA-CR—144843;RSCR—76-1). NTIS, PC A05/MF A01.

Magnetospheric radio noise spectra (30 kHz to 10 MHz) taken by IMP-6 and RAE-2 exhibit time varying characteristics which are related to spacecraft position and magnetospheric processes. In the midfrequency range (100-1000 kHz) intense noise peaks rise a factor of 100 or more above background; 80% of the peak frequencies are within the band 125 kHz to 600 kHz, and the peak occurs most often (18% of the time) at 280 kHz. Bandwidths of the peaks range from about 100 kHz to more than 500 kHz; most often the lower cutoff is at about 100 kHz and the upper at 380 kHz for a total bandwidth of 280 kHz. This intense mid-frequency noise was detected at radial distances from 1.3 Re to 60 Re on all sides of the earth (i.e., all local times) during magnetically quiet as well as disturbed periods. Maximum occurrence of the mid-frequency noise is in the evening to midnight hours where splash-type energetic particle precipitation takes place.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

55238 **Laser-produced x-ray spectra of the fluorine isoelectronic sequence for Zn, Ge, and Se dagger.** Burkhalter, P.G.; Doschek, G.A.; Feldman, U.; Cowan, R.D. (Naval Research Laboratory, Washington, D.C. 20375). *J. Opt. Soc. Am.;* 67: No. 6, 741-747(Jun 1977).

The transition $2p^5—2p^4 3s$ and $2p^5—2p^4 3d$ in fluorine-like Zn, Ge, and Se have been measured in laser-produced x-ray spectra. The experimental spectral data agree well with ab initio atomic structure calculations based on Hartree-Fock wave functions. Classifications of the F I-like lines in these spectra are based on isoelectronic extrapolations and theoretical calculations.

55239 **Molecular orbital studies of methanol polymers using a minimal basis set.** Curtiss, L.A. (Chemical Engineering Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* 67: No. 3, 1144-1149(1 Aug 1977).

Ab initio minimal basis set LCAO—SCF molecular orbital calculations have been carried out to determine the binding energies and structures of small groups of methanol molecules [(CH_3OH)/sub n/ n = 3,4,5,6] with particular emphasis on aspects relevant to experimental measurements on methanol vapor. Cyclic structures are found to be more stable than the open structures for the trimer and higher polymers. The methanol polymers are very similar to the previously studied water polymers in binding energy and structure. A special stability found for the tetramer in infrared, PVT, heat capacity, and thermal conductivity measurements is consistent with the theoretical results.

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 54809

55240 (JAERI-M—6813) **Numerical simulation for design of a two-stage acceleration system in a high power ion source.** Ohara, Y. (Japan Atomic Energy Research Inst., Tokyo). Nov 1976. 27p. Dep. NTIS (US Sales Only), PC A03/MF A01.

In design of the neutral beam injectors for JT-60, the optimum configuration of extraction grids and the operating conditions were studied numerically for a two-stage acceleration in a high power ion source. Results of the calculations show the feasibility to extract a proton beam with energy 75 keV and current 15 A of about 0.6 degree divergence from the 12 cm diameter extraction grids of transparency 40%. Beam divergence in the two-stage configuration depends largely on the field intensity ratio; the optimum ratio that gives a minimum beam divergence is about 0.3 - 0.5. Possibility of beam focusing by aperture displacement is also treated with a simple model of thin-lens approximation.

ATOMIC AND MOLECULAR PROPERTIES

55241 (CONF-770713—1) **Selective single atom detection in a 10^{19} atom background.** Hurst, G.S.; Nayfeh, M.H.; Young, J.P.; Payne, M.G.; Grossman, L.W. (Oak Ridge National Lab., Tenn. (USA)). Jun 1977. Contract W-7405-ENG-26. 13p. Dep. NTIS, PC A02/MF A01.

From 3. international conference on laser spectroscopy; Jackson Hole, Wyoming, United States of America (USA) (4 Jul 1977).

A recent energy pathways model for the de-excitation of excited helium gas [Payne et al., J. Chem. Phys. 63, 1422 (1975)] suggested that a key step $He(2^1P) + He(1^1S)$ yields $He(2^1S) + He(1^1S)$ had an unusually large cross section. This led to the need to measure the population of $He(2^1S)$ as a function of time following charged-particle excitation of $He(2^1P)$. The principle of resonance ionization spectroscopy is explained, and the ratio of $He(2^1S)$ to direct ionization is shown as a function of laser energy per pulse. Conditions for resonance ionization of atoms in their ground states are described; studies were made of two-photon ionization of Cs—Ar mixtures with the broadened Cs(7p) as an intermediate state. The topic of photodissociation of molecules: time-resolved sources of free atoms is discussed; all of the CsI molecules in the central portion of a laser beam could be dissociated to neutral Cs and I atoms in their ground states. The method is well suited to rather direct measurements of the diffusion of a small number of alkali atoms in various gases and to a remarkably simple determination of the rate of reaction of free atoms with various other atoms or molecules. One-atom detection of Cs in a background of 10^{19} atoms of Ar was demonstrated with a proportional counter. 12 figs. (RWR)

55242 (LBL—6264) **Optical quadrupole sum-frequency generation in sodium vapor.** Bethune, D.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1977. Contract W-7405-ENG-48. 86p. Dep. NTIS, PC A05/MF A01.

Thesis.

It is shown that second order nonlinear optical processes such as sum and difference generation can be observed in isotropic media, despite the fact that such processes are forbidden in the dipole approximation. A theoretical treatment of quadrupole sum and difference frequency generation is given, which includes the effects of spin-orbit splitting. The symmetry of the vapor is used to derive the form of the quadrupole susceptibility tensor, and the quadrupole moment tensor is then expressed as a scalar susceptibility multiplied by a tensor constructed directly from the input field polarization vectors. The expression shows that two noncollinear beams must be used. The effect of applying a magnetic field is derived. Expressions for phase matching and output power are found. In sodium vapor one observed quadrupole sum frequency generation (QSFG) of ultraviolet light. The output radiation showed very sharp resonant enhancement when $\omega_1 + \omega_2$ was tuned near the 3s yields 4d quadrupole allowed transition of Na. The experimental results generally confirm the theoretical predictions. Deviations of the data from the simple theory can be satisfactorily accounted for by the effects of two photon saturation, induced index of refraction changes and

single and multi-photon absorption. It is also shown that by applying a D.C. electric field to the sodium vapor, interference effects between QSFG and D.C. induced, third-order sum-frequency generation may be observed, allowing an accurate determination of quadrupole matrix elements relative to dipole matrix elements of atoms. This technique is used to measure the value of the 3s to 4d quadrupole transition moment of Na. The result is [3s/zz/2/4d] = (2.2 +- 0.4) a_0^2. Finally, the generalization of the dipole forbidden susceptibilities to the case of quadrupole pumped processes is discussed, with difference frequency generation in Cs vapor considered as an example.

55243 Kinetic energy distributions from unimolecular decay: predictions of the Langevin model. Klots, C.E. (Oak Ridge National Lab., TN). *J. Chem. Phys.;* **64**: No. 11, 4269-4275(1 Jun 1976).

The kinetic energy released in a unimolecular decomposition is examined within the framework of quasiequilibrium theory. It is assumed that the motion is governed by the long-range forces between the separating moieties. Explicit formulas are obtained for cases where the total angular momentum is either very low or very high. Comparison with experiment and with other formulations is made.

55244 Emission spectrum of curium. Worden, E.F. (Univ. of California, Livermore); Hulet, E.K.; Gutmacher, R.G.; Conway, J.G. *At. Data Nucl. Data Tables;* **18**: No. 5, 459-495(Nov 1976).

The curium emission spectrum was observed from 2400 to 11,200 A using electrodeless lamps as sources. Accurately measured wavelengths of 2034 of the strongest ^{244}Cm lines are reported. The wavelengths, wavenumbers, and relative intensities are given. In addition, Zeeman-effect data, spectrum assignment as neutral or singly ionized lines, isotope shift, and energy-level classifications are given for most of the lines.

55245 Lifetimes of excited states of the samarium atom. Blagoev, K.B.; Komarovskii, V.A.; Penkin, N.P. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 3, 238-239(Mar 1977).

The lifetimes of thirteen levels of Sm I belonging to the configurations $4f^6 6s6p$ and $4f^5 5d6s^2$ were measured by the multichannel delayed coincidence method. The lifetimes obtained were used to calculate the coefficient for converting to an absolute scale the relative oscillator strengths of Sm I spectral lines measured previously by the Rozhdestvenskii hook method.

55246 Relative oscillator strengths of the atomic lines of erbium. Blagoev, K.B.; Kamarovskii, V.A. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 3, 340-341(Mar 1977).

Energy-level transitions of Er atoms are studied employing Rozhdestvenskii's method. The experiment was performed in a heated porcelain tube.(AIP)

55247 Hyperfine-structure and isotope-shift measurements on Dy I λ5988.562 using high-resolution laser spectroscopy and an atomic beam. Childs, W.J.; Goodman, L.S. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Opt. Soc. Am.;* **67**: No. 6, 747-751(Jun 1977).

The fluorescence pattern of λ5988 in Dy I has been examined using a sweepable, single-frequency dye laser incident on an atomic beam. The 23 resolved components are interpreted, and the hfs constants and J value of the upper level are assigned. The isotope shifts for the line, including those involving the odd isotopes, are evaluated.

55248 Near infrared reflectance spectra and analysis of H_2S frost as a function of temperature. Ferraro, J.R.; Fink, U. (University of Arizona, Lunar and Planetary Laboratory, Tucson, Arizona 85721). *J. Chem. Phys.;* **67**: No. 2, 409-413(15 Jul 1977).

The reflection spectra of H_2S frost in the near infrared region (1.6—4 μm), as a function of temperature to 62 degreeK, were measured. Analyses of these spectra were made, and assignments for the most intense combinations attempted. Dramatic changes in spectra are observed from 62—143 degreeK, connected with a phase transition between a tetragonal, low-temperature phase and a cubic, high-temperature phase, occurring at 125 +- 5 degreeK. The data present evidence for only two phases being involved for H_2S frost.

55249 Energy separation between the open (C$_2$/sub v/) and closed (D$_3$/sub h/) forms of ozone. Lucchese, R.R.; Schaefer III, H.F. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **67**: No. 2, 848-849(15 Jul 1977).

Configuration interaction calculations were performed using the currently developed BERKELEY system of programs on ozone, and the energy difference between closed and open isomers was determined. (AIP)

55250 Vibrational relaxation of uranium hexafluoride: Ultrasonic measurements. Bass, H.E.; Shields, F.D.; Breshears, W.D.; Asprey, L.B. (Department of Physics and Astronomy, The University of Mississippi, University, Mississippi 38677). *J. Chem. Phys.;* **67**: No. 3, 1136-1138(1 Aug 1977).

Ultrasonic attenuation has been measured in UF_6 at room temperature over an f/P range of 20 kHz/atm to 70 MHz/atm. A single relaxation process was inferred with an isothermal relaxation time of 5.7×10^{-8} sec-atm. Assuming the three higher energy modes are coupled by fast transfer processes to the three lower energy modes and that the three lower energy modes relax together in parallel, it was found that the rate of de-excitation of the first excited level of the lower energy modes is 4.2×10^{-8} $sec^{-1}xatm^{-1}$. This corresponds to an average of 17 collisions to transfer a quantum of vibrational energy to translation.

COLLISION PHENOMENA

55251 (AD-A—038806) **Cross sections for thermal reactions between uranium atoms and atmospheric species. Final report 1 Nov 74—31 Dec 76.** Fite, W.L.; Patterson, T.A.; Siegel, M.W. (Extranuclear Labs., Inc., Pittsburgh, Pa. (USA)). 31 Dec 1976. Contract F19628-74-C-0215. 87p. NTIS PCA05/MF A01.

Experimental studies of associative ionization reactions involving uranium and other metal atoms in collisions with O_1O_2 and other atmospheric species are described. Absolute reaction cross sections are obtained by comparison with the previously measured cross sections for the U + O and U + O_2 reactions. Negative ions have been observed as products in some of the reactions; however, these channels account for less than 10% of the total reaction cross section. No reaction products are observed for associative ionization between atomic oxygen and selected oxides of Mo, W and Ti. Both thorium and uranium have large total cross sections of order 10^{-15} cm^2, for associative ionization with ozone. A simple, efficient ozone source for beam experiments is described.

55252 Nonadiabatic transitions between decaying states. Bazylev, V.A.; Zhevago, N.K.; Chibisov, M.I. (I. V. Kurchatov Atomic Energy Institute). *Sov. Phys. - JETP (Engl. Transl.);* **44**: No. 4, 671-679(Oct 1976).

Processes of the charge exchange type between multiply charged ions and atoms are investigated taking into account the decay of states due to Auger ionization. It is shown that for sufficiently slow collisions with a small resonance defect the decay of states can significantly alter the probability of elastic collisions and the probability of charge exchange. It is also shown that along with the traditional charge exchange scheme a stepwise charge exchange is possible as a result of coherent interaction of states, between which electron transitions occur, via virtual states of the continuous spectrum. The probability of stepwise charge exchange is calculated taking into account the interference between two channels.

55253 Decay and excitation of a quantum system following two successive sudden changes in the Hamiltonian. Golubkov, G.V.; Dalidchik, F.I.; Ivanov, G.K. (Institute of Chemical Physics, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **44**: No. 4, 679-683(Oct 1976).

The response of a quantum system to two successive sudden changes of the Hamiltonian is considered. The dependence of the probabilities for various processes on the dwell time tau of the system in the intermediate state is investigated, the interaction in the intermediate state being represented by a repulsive potential of the form γ/r^2. Analytic expressions are found for the limiting cases of large and small values of tau. The deviations of the spectra of the dissociation products of diatomic molecules from the Franck—Condon distribution for resonance scattering of electrons is investigated in detail. A possible isotope effect for hydrogen molecules is noted.

55254 Coherent population of quasimolecular states by atomic scattering. Bobashev, S.V.; Kharchenko, V.A. (A. F. Ioffe Physicotechnical Institute, USSR Academy of Sciences, Leningrad). *Sov. Phys. - JETP (Engl. Transl.);* **44**: No. 4, 693-698(Oct 1976).

An analysis is given of the conditions for coherent population of the states of a quasimolecule produced during atomic scattering. It is shown that, within the framework of the model with isolated nonadiabatic interaction regions, the conditions for coherent population of the quasimolecular states improve with decreasing Landau—Stueckelberg phases which arise in the region of the population of the quasimolecular terms. Existing experimental data are used to establish conditions for coherent population on the assumption of an effective interaction between these quasimolecular terms throughout the population region due to the rotation of the internuclear axis. Expressions are obtained for the depth of modulation of the total cross sections for different mechanisms of mixing of the interfering terms at large distances. The results are compared with measured total excitation cross sections for collisions between sodium ions and neon atoms.

55255 Controlled fusion atomic data center. Barnett, C.F. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 567(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55256 Interference effects in rotational state distributions: Propensity and inverse propensity. McCurdy, C.W.; Miller, W.H. (Department of Chemistry, and Materials and Molecular Research Division of the Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **67**: No. 2, 463-468(15 Jul 1977).

Semiclassical scattering theory has been used to investigate interference effects in rotational state distributions for inelastic atom—diatom collisions. The Δj=even selection rule for homonuclear molecules is seen semiclassically to be an interference effect, and when this symmetry is weakly broken—i.e., an "almost homonuclear" molecule, one for which the odd anisotropy is much smaller than the even anisotropy—the interference persists in the form of a propensity rule, σ (odd Δj) $<<\sigma$ (even Δj). If the odd anisotropy is sufficiently large, however, one can see an inversion of the normal propensity, i.e., it can happen that σ (odd Δj) $<\sigma$ (even Δj). It is suggested that rotationally state-selected experiments which resolve this interference structure would be an extremely sensitive measure of the anisotropy in the interaction potential.

55257 Energy transfer in collisions of excited Na atoms with NO molecules. Silver, J.A.; Blais, N.C.; Kwei, G.H. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **67**: No. 2, 839-841(15 Jul 1977).

Measurements of scattering angle and product velocity distributions are reported for a crossed molecular beam study of excited Na atoms and NO molecules. These results provide evidence that most of the electronic energy is partitional between relative translation and vibration of the NO molecule. (AIP).

ATOMIC AND MOLECULAR THEORY

55258 (CONF-770645—1) **Adiabatic following in two-photon transition.** Nayfeh, M.H.; Nayfeh, A.H. (Oak Ridge National Lab., Tenn. (USA); Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). 1977. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From 4. Rochester conference on coherence and quantum optics; Rochester, New York, United States of America (USA) (8 Jun 1977).

There has been much interest recently in coherent multiphoton transitions in many-level systems. The present work considers the effect of relaxation in the response of a three-level system to a smoothly varying, near-resonant, two-photon field. The relaxation-dependent contributions to the nonlinear refractive index are calculated. It is shown that the coherent interaction of two smoothly varying, near-resonant, two-photon pulses with a three-level system can be described by "two-photon damped Bloch equations" which are analogous to those for a one-photon transition in a two-level system except for the presence of a two-photon coupling and a frequency shift. 1 figure. (RWR)

55259 Wave equation of a nonlinear triatomic molecule and the adiabatic correction to the Born—Oppenheimer approximation. Bardo, R.D.; Wolfsberg, M. (Department of Chemistry, University of California, Irvine, California 92717). *J. Chem. Phys.;* **67**: No. 2, 593-603(15 Jul 1977).

The wave equation for a nonlinear polyatomic molecule is formulated in molecule-fixed coordinates by a method originally due to Hirschfelder and Wigner. Application is made to a triatomic molecule, and the wave equation is explicitly presented in a useful molecule-fixed coordinate system. The formula for the adiabatic correction to the Born—Oppenheimer approximation for a triatomic molecule is obtained. The extension of the present formulation to larger polyatomic molecules is pointed out. Some terms in the triatomic molecule wave equation are discussed in detail.

55260 Theory of resonant Raman scattering in the strong vibronic coupling limit—a Green's function approach. Hong, H. (Department of Chemistry and Radiation Laboratory University of Notre Dame, Notre Dame, Indiana 46556). *J. Chem. Phys.;* **67**: No. 2, 801-812(15 Jul 1977).

A Green's function approach for resonant Raman scattering is proposed here, which is suitable for both weak and strong vibronic couplings. The formalism is based on the solution of the exact Green's function in the Longuet—Higgins representation, using the solutions to the static equations in ordinary molecular quantum mechanics as the basis set. The physical meaning of various interaction schemes becomes clear in this representation. In particular, the vibronic coupling is based on the interactions between individual zero-order vibronic levels and is carried through to infinite order, whereas the traditional first-order results only account for the emission of one single vibrational quantum. Nonadiabatic contributions are also contained in the formulation. The method is applied to the following cases: (1) the change in nuclear equilibrium position due to electronic excitation, (2) vibronic coupling involving two excited states, and (3) the change in nuclear potential (force constants) due to electronic excitation. Numerical results show that the convergence is excellent even for large vibronic coupling and in exact resonance region. Furthermore, all the physical quantities of interest, such as Raman cross sections of fundamentals and overtones, absorption profiles, Franck—Condon factors, quantum yields can be obtained at the same time in this unified approach.

55261 Theory of resonant Raman scattering. II. Overtones and hot bands. Hong, H. (Department of Chemistry and Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556). *J. Chem. Phys.;* **67**: No. 2, 813-823(15 Jul 1977).

Resonant Raman scattering is discussed in the framework of the Green's function method in both the strong and weak vibronic coupling limits. We further elaborate on the meaning of each matrix element of the Green's function, evaluated in the convenient basis set which is commonly referred to as the Longuet—Higgins representation. Cross sections for absorption, Rayleigh, Raman fundamentals, Raman overtones, hot bands, etc., can all be related to the matrix elements of the Green's function. It is further emphasized that only in the vibronic view elaborated here does a simple and direct correlation exist between the light scattering processes and the Green's functions. Some typical excitation profiles for overtones and hot bands are calculated, and the consequences of strong vibronic couplings are discussed in contrast to the weak vibronic coupling case.

55262 Infrared studies of one-dimensional conductors of the cation-deficient type: $M_{1.75}[Pt(CN)_4]1.5H_2O$ where M=K, Rb, or Cs. Ferraro, J.R.; Basile, L.J.; Williams, J.M. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **67**: No. 2, 742-745(15 Jul 1977).

Infrared studies of one-dimensional conductors of the cation-deficient type M_1/sub ./$_{75}[Pt(CN)_4]1.5H_2O$, where M=K, Rb, or Cs, are reported. Results are compared with those previously reported for the anion-deficient conductors as well as between the starting materials, unoxidized $K_2[Pt^{+2}(CN)_4]3H_2O$ and fully oxidized $K_2[Pt^{+4}(CN)_4Br_2]$. It is observed that some of the infrared-active vibrations are sensitive to the oxidation state of Pt. The trends are explained in terms of an increase in metal—CN π-back bonding, and a decrease in the metal—carbon sigma bonding. Spectral data are included for the organic guanidinium tetracyanoplatinate 1-D conductor.

FLUID PHYSICS

55263 Freezing-controlled penetration of a saturated liquid into a cold tube. Epstein, M.; Yim, A.; Cheung, F.B. (Argonne National Laboratory, Reactor Analysis and Safety Division, Argonne, III.). *J. Heat Transfer;* **99**: No. 2, 233-238(May 1977).

The penetration of a saturated liquid (a liquid at its freezing temperature) into a tube that is initially empty and maintained at a temperature below the freezing temperature of the liquid is treated theoretically and experimentally. A convenient approximate method is introduced which involves postulating a reasonable functional form for the instantaneous shape of the frozen layer along the tube wall. Graphical velocity-time and penetration distance-time curves are presented displaying the principal effects of a single dimensionless parameter. In the limit of negligible liquid inertia, shown to be relevant to high Prandtl number materials, a closed-form expression for the liquid penetration length is obtained. The expression compares well with experimental results.

SUPERFLUIDITY

55264 Types of vortex solutions in superfluid He^3. Chechetkin, V.R. (Moscow Physico-technical Institute). *Sov. Phys. - JETP (Engl. Transl.);* **44**: No. 4, 766-772(Oct 1976).

Vortex solutions in the A and B phases of superfluid He^3 are classified on the basis of the Ginzburg-Landau equations. It is shown that any vortex state can be characterized by three quantum numbers. Some of the results are directly applicable to the theory of nematic liquid crystals. Volume solutions are set up which may exist for arbitrary values of the coefficient K_{22}, and it is shown that either radial or circular disclinations may exist, depending on the relation between the Frank coefficients.

55265 Line and point singularities in superfluid He^3. Volovik, G.E.; Mineev, V.P. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **24**: No. 11, 561-563(5 Dec 1976).

A classification is presented for the topologically stable singularities in the A and B phases of He^3, with the spin-orbit interaction taken into account.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

ELECTROMAGNETIC INTERACTIONS

55266 Electroproduction of forward protons up to Q^2 = 9.5 GeV^2. Bebek, C.J.; Brown, C.N.; Kline, R.V.; Pipkin, F.M.; Raither, S.W.; Sisterson, L.K.; Browman, A.; Hanson, K.M.; Larson, D.; Silverman, A. (High Energy Physics Laboratory, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev., D;* **15**: No. 11, 3077-3081(1 Jun 1977).

We report new measurements of inclusive proton electroproduction. Data were taken with a hydrogen target at the (W,Q^2) points (2.2 GeV, 1.2 GeV^2), (2.7, 2.0), (2.7, 3.3), (2.7, 6.2), and (2.7, 9.5) and with a deuterium target at (2.2, 1.2), (2.7, 2.0), (2.7, 6.2), and (2.7, 9.5). The invariant structure function is studied as a function of W, Q^2, ω, and x'. The data are compared with the predictions of the constituent-interchange model.

55267 Scalar-transverse separation of electroproduced $K^+\Lambda$ and $K^+\Sigma^0$ final states. Bebek, C.J.; Brown, C.N.; Kline, R.V.; Pipkin, F.M.; Raither, S.W.; Sisterson, L.K.; Browman, A.; Hanson, K.M.; Larson, D.; Silverman, S. (High Energy Physics Laboratory, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev., D;* **15**: No. 11, 3082-3084(1 Jun 1977).

We present evidence for a large scalar contribution to the cross section for the reaction ep yields $eK^+\Lambda$. No evidence for a scalar contribution is found for the reaction ep yields $eK^+\Sigma^0$. This is reminiscent of the results for the π^+n and $\pi^+\Delta^0$ final states.

55268 Inclusive charged-pion electroproduction. Bebek, C.J.; Brown, C.N.; Herzlinger, M.S.; Holmes, S.D.; Lichtenstein, C.A.; Pipkin, F.M.; Raither, S.W.; Sisterson, L.K. (High Energy Physics Laboratory, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev., D;* **15**: No. 11, 3085-3104(1 Jun 1977).

We report measurements of semi-inclusive pion electroproduction from both hydrogen and deuterium targets carried out at the Wilson Synchrotron Laboratory at Cornell University. Measurements were made at the (W,Q^2) points (2.15 GeV, 1.2 GeV^2), (2.15, 4.0), and (3.11, 1.2) with hydrogen and deuterium, and at (2.15, 2.0), (2.67, 3.3), and (3.11, 1.7) with hydrogen only. The invariant virtual-photoproduction cross section for pions scaled by the total cross section is studied as a function of x', P/sub T/ ², W, and Q^2. The invariant structure function shows no Q^2 dependence and a weak W dependence. The ratio of π^+ to π^- production is also presented, but a distinction between a universal ω or W dependence cannot be made.

STRONG BARYON-INDUCED INTERACTIONS

55269 π^+-, K^+-, pp, and p-barp elastic scattering from 50 to 175 GeV/c. Ayres, D.S.; Diebold, R.; Maclay, G.J.; Cutts, D.; Lanou, R.E. Jr.; Levinson, L.J.; Massimo, J.T.; Litt, J.; Meunier, R.; Sogard, M.; Gittelman, B.; Loh, E.C.; Brenner, A.E.; Elias, J.E.; Mikenberg, G.; Guerriero, L.; Lavopa, P.; Maggi, G.; DeMarzo, C.; Posa, F.; Selvaggi, G.; Spinelli, P.; Waldner, F.; Barton, D.S.; Butler, J.; Fines, J.; Friedman, J.I.; Kendall, H.W.; Nelson, B.; Rosenson, L.; Verdier, R.; Gottschalk, B.; Anderson, R.L.; Gustavson, D.; Rich, K.; Ritson, D.M.; Weitsch, G.A. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **15**: No. 11, 3105-3138(1 Jun 1977).

The differential cross sections for the elastic scattering of π^+, π^-, K^+, K^-, p, and p-bar on protons have been measured in the t interval -0.04 to -0.75 GeV^2 at five momenta: 50, 70, 100, 140, and 175 GeV/c. The t distributions have been parametrized by the quadratic exponential form $d\sigma/dt = A \exp(B \text{ abs. value(t)} + C \text{ abs. value(t)}^2$ and the energy dependence has been described in terms of a single-pole Regge model. The pp and K^+p diffraction peaks are found to shrink with $\alpha' \sim 0.20$ and ~ 0.15 GeV^{-2}, respectively. The p-barp diffraction peak is antishrinking while π^+- and K^-p are relatively energy-independent. Total elastic cross sections are calculated by integrating the differential cross sections. The rapid decline in σ/sub el/ observed at low energies has stopped and all six reactions approach relatively constant values of σ/sub el/. The ratio of σ/sub el//σ/sub tot/ approaches a constant value for all six reactions by 100 GeV, consistent with the predictions of the geometric-scaling hypothesis. This ratio is $\sim$ 0.18 for pp and p-barp, and $\sim$ 0.12—0.14 for π^+- and K^+-. A crossover is observed between K^+p and K^-p scattering at abs. value t approx =0.19 GeV^2, and between pp and p-barp at abs. value t approx=0.11 GeV^2. Inversion of the cross sections into impact-parameter space shows that protons are quite transparent to mesons even in head-on collisions. The probability for a meson to pass through a proton head-on without interaction inelastically is $\sim$ 20%, while it is only $\sim$ 6% for an incident proton or antiproton. Finally, the results are compared with various quark-model predictions.

STRONG MESON-INDUCED INTERACTIONS

55270 Elastic scattering of π^-, K^-, and p-bar from hydrogen at 8 and 16 GeV/c. Russ, J.S.; Birnbaum, D.; Edelstein, R.M.; Hien, N.C.; McMahon, T.J.; Mucci, J.F.; Stein, N.A.; Anderson, E.W.; Bleser, E.J.; Blieden, H.R.; Collins, G.B.; Garelick, D.; Menes, J.; Turkot, F. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., D;* **15**: No. 11, 3139-3154(1 Jun 1977).

In a single-arm spectrometer experiment, high-precision measurements of $d\sigma/dt$ for π^-p, K^-p, and p-barp elastic scattering have been made at 8 and 16 GeV/c. The π^-p data show rich structure at 8 GeV/c, indicative of strong non-Pomeron contributions, while the 16-GeV/c data are much smoother. For -t < or approx = 1 $(GeV/c)^2$ there is a strong s dependence, while there is very little for -t < 1 $(GeV/c)^2$. For p-barp scattering the forward region is smoothly diffractive for -t < 0.4 $(GeV/c)^2$ and shows antishrinkage. The exponential slope parameter b is measured to be 12.36 +- 0.04 $(GeV/c)^{-2}$ at 8 GeV/c and 11.40 +- 0.04 $(GeV/c)^{-2}$ at 16 GeV/c. The structure near -t = 0.6 $(GeV/c)^2$ seen at lower energies is still obvious at 16 GeV/c. The K^-p data show some structure at 8 GeV/c, but can be represented adequately by a quadratic exponential form. At 16 GeV/c the K^-p angular distribution shows antishrinkage and lies above the 8-GeV/c cross section for 0.11 < -t < 0.8 $(GeV/c)^2$.

55271 π^-p interactions at 205 GeV/c: Multiplicities of charged and neutral particles; production of neutral particles. Ljung, D.; Bogert, D.; Hanft, R.; Huson, F.R.; Kahn, S.; Pascaud, C.; Pruss, S.; Smart, W.M.; Bingham, H.H.; Chew, D.M.; Daugeras, B.Y.; Fretter, W.B.; Goldhaber, G.; Graves, W.R.; Johnson, A.D.; Kadyk, J.A.; Stutte, L.; Trilling, G.H.; Winkelmann, F.C.; Yost, G.P. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **15**: No. 11, 3163-3180(1 Jun 1977).

A study of 205-GeV/c π^-p interactions has been made with a 48 800-picture exposure in the bare Fermilab 30-inch hydrogen bubble chamber. The average number of charged particles produced per inelastic interaction is 7.99 +- 0.06. The elastic cross section is 3.18 +- 0.13 mb and the total cross section is 24.19 +- 0.44 mb. The inclusive cross sections for neutral-particle production are $\sigma(\gamma)$ = 171.3 +- 15.3 mb, $\sigma(K^0$/sub S/) = 3.64 +- 0.61 mb (x < 0.3), σ (Λ) = 1.71 +- 0.34 mb (x < 0.3), and $\sigma(\Lambda$-bar) = 0.59 +- 0.23 mb (x < 0.1). The average number of π^0's produced per inelastic collision is consistent with a linear rise with the number of charged particles, and about equal to the number of produced π^- or π^+. The average number of K^0's, Λ's, and Λ-bar's is consistent with very little dependence on the number of charged particles. General characteristics of neutral-particle production are presented and compared with other experiments. For each topology the produced neutral energy is $\sim$ 1/3 of the incident energy.

55272 High-statistics study of the reactions π^-p yields K^-K^+n and π^+n yields K^-K^+p at 6 GeV/c. Pawlicki, A.J.; Ayres, D.S.; Cohen, D.; Diebold, R.; Kramer, S.L.; Wicklund, A.B. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **15**: No. 11, 3196-3221(1 Jun 1977).

The Argonne Effective Mass Spectrometer has been used for a high-precision study of the reactions π^-p yields K^-K^+n (110 000 events) and π^+n yields K^-K^+p (50 000 events) at 6 GeV/c for K^-K^+ masses below 1750 MeV and momentum transfers -t < 0.40 GeV^2. Comparison of the two reactions isolates interferences between isospin-0 and isospin-1 K^-K^+ states. We observe f-$A_2{}^0$, f'-$A^0{}_2$, and f-f' interferences in the $Y^0{}_4$ moment and find f' production to have a substantial contribution from some mechanism other than pion exchange. We present values for the f' mass (1506 +- 5 MeV), width (66 +- 10 MeV), and branching ratio [(f' yields $\pi\pi$/f' yields all) = (1.2 +- 0.4) %]. The relative f-f' production phase is found to be 170 +- 10°, the 2^{++} nonet mixing angle is determined to be 32.5 +- 0.5°, which is less than the ideal value. The measured relative f-$A^0{}_2$ production phase of $(63^{+11}{}_{-13})$ degree confirms a prediction of Irving and Michael based on duality and vector-meson production studies. The K-barK branching ratio of the f meson is measured to be (f yields K-barK/f yields all) = (3.8 +- 0.4) %. An SU(3) prediction for the ratio of the rhoKK to the rho$\pi\pi$ coupling is found to agree with the data. In addition to the isospin-0 S*, substantial isospin-1 S-wave production is observed near the K^-K^+ threshold and the effects of the recently reported S-wave enhancement of mass $\sim$ 1300 MeV are observed. Our results show that the enhancement has isospin 0, with a slow variation of phase.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

ELECTROMAGNETIC INTERACTIONS

55273 Molecular charmonium and C-exotic mesons. Tuan, S.F. (Department of Physics and Astronomy, University of Hawaii at

Manoa, Honolulu, Hawaii 96822). *Phys. Rev., D;* **15**: No. 11, 3478-3480(1 Jun 1977).

Recently De Rujula et al. and Okun and Voloshin suggested that several peaks in $e^- e^+$ annihilation cross section into hadrons are due to resonances between two charmed mesons in a relative P wave. Such a picture raises at once the question whether C-exotic mesons formed also from two charmed mesons (or four-quark molecules) in a relative P wave may not coexist at comparable mass. We examine briefly here the spectroscopy for C-exotic mesons with J/sup P/ = 0^-, I/sup G/ = 0^-, 1^+, and J/sup P/ = 1^-, I/sup G/ = 0^+, 1^-.

55274 Hadron and quark mass differences. Peaslee, D.C. (Physics Department, Brown University, Providence, Rhode Island 02912). *Phys. Rev., D;* **15**: No. 11, 3495-3498(1 Jun 1977).

An estimate $D^+ - D^0$ 5 MeV is made on the basis of a phenomenological quark model in which baryon mass differences are fitted exactly and simple corrections are made for the looser structure of bosons. The other boson fits are satisfactory except for predicting rho$^+$ - rho^0 0.3 MeV. An incidental quark mass difference is obtained: m/sub d/ - m/sub u/ 10 MeV from sources other than ordinary QED. It is suggested that weak interactions with the heavy charmed quark are responsible, so that [(m/sub d/ - m/sub u/)/(m/sub s/ - m/sub u/)]$^{1/2}$ θ/sub C/, the Cabibbo angle.

WEAK INTERACTIONS

55275 Analysis of $e^+ + e^-$ yields $V^+ + V^-$ yields $e^+ + \nu$/sub e/ + μ^- + ν-bar/sub μ/ with beam polarization. Lauwers, P.G.; Gavrielides, A.; Kuo, T.K. (Physics Department, Purdue University, West Lafayette, Indiana 47907). *Phys. Rev., D;* **15**: No. 11, 3222-3226(1 Jun 1977).

We study the process $e^+ + e^-$ yields $V^+ + V^-$ yields $e^+ + \nu$/sub e/ + μ^- + ν-bar/sub μ/ where V^+- are vector bosons. Transverse polarization of the incident beams, as well as anomalous magnetic dipole and anomalous electric quadrupole moments of the vector bosons, are taken into account. Analytic expressions are obtained for the relevant differential cross sections. This process is a possible explanation of the anomalous eμ events in the SPEAR $e^+ e^-$ annihilation experiment.

55276 Reconciliation of deep-inelastic neutrino and antineutrino measurements with the four-flavor parton model. Budny, R. (Rockefeller University, New York, New York 10021). *Phys. Rev., D;* **15**: No. 11, 3227-3231(1 Jun 1977).

The high-y anomaly and the anomalous increase of the total antineutrino cross section at high energy appear consistent with the usual parton model of four flavors if the first moment of the fractional momentum distribution of the s-bar parton is large compared with that of the u-bar, d-bar, and s partons. Various consequences and tests of this hypothesis are discussed.

55277 ν- and ν-bar-induced neutral-current processes and SU(2)xU(1) gauge models of quarks. Hagiwara, T.; Takasugi, E. (The Rockefeller University, New York, New York 10021). *Phys. Rev., D;* **15**: No. 11, 3232-3246(1 Jun 1977).

By examining both ν- and ν-bar-induced neutral-current inclusive processes on an isoscalar target and elastic scattering processes on a proton target, we derive two constraints on the fermionic representation in SU(2)xU(1) gauge models. There are five classes of models that are consistent with these constraints. For each class the upper bound of $\sin^2\theta$/sub W/ is determined. We also list models for each class with a minimum number of quarks. For these models we analyze the data of νp and ν-barp elastic scattering processes. We also examine both ν- and nu-bar-induced charged- and neutral-current inclusive processes on a proton target.

55278 Transverse-momentum distribution of the massive μ pair using dimensional counting. Gunion, J.F. (Department of Physics, University of California, Davis, California 95616). *Phys. Rev., D;* **15**: No. 11, 3317-3320(1 Jun 1977).

We discuss qualitatively and quantitatively the expectations for parton transverse-momentum distributions and their effect upon μ-pair production.

55279 Cabbibbo-suppressed nonleptonic decays of charmed mesons. Donoghue, J.F.; Wolfenstein, L. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., D;* **15**: No. 11, 3341-3345(1 Jun 1977).

Test of the Glashow-Illiopoulos-Maiani Hamiltonian based on SU(3) symmetry are presented that do not depend on any enhancment assumptions. The significance of possible failures of these predictions are discussed with emphasis on alternative models involving right-handed currents.

55280 Gauge theories of microweak CP violation. Lee, B.W. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **15**: No. 11, 3394-3406(1 Jun 1977).

We investigate systematically the condition that CP violation in abs. value (ΔS) = 1 processes is "microweak" [i.e., of order of G/sub F/ϵ (m/m/sub W/)^2 where m is a typical hadronic mass] naturally (i.e., for all values of complex parameters of the theory) in SU(2)xU(1) gauge theories of weak and electromagnetic interactions. We consider only those models in which CP violation occurs in the quark mass terms. The conditions for microweak CP violation in abs. value (ΔS) = 1 processes are that (1) quarks of charge -1/3 and of a given chirality have the same weak isospin I and I_3, and (2) quarks of charge 2/3 (-4/3, if they exist) and quarks of charge -1/3 do not belong to the same weak isomultiplets for at least one chirality. Special attention is given to a more restricted class of models in which (1) quarks of a given charge and chirality have the same weak isospin I and I_3, and (2) quarks of charge q and quarks of charge q + 1 do not belong to the same isomultiplets for at least one chirality. In such models, the electric dipole moment of a quark arises only in second-order weak interactions, and is estimated to be of order of 10^{-30} cm. Several examples of this class of models are given, one of which is the six-quark model of Kobayashi and Maskawa.

55281 Constraints on gauge theories with diagonal neutral currents. Paige, F.E.; Paschos, E.A.; Trueman, T.L. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **15**: No. 11, 3416-3420(1 Jun 1977).

We derive constraints for the representation content of SU(2)xU(1) gauge theories, whose neutral weak interactions conserve all flavors. Among the results are the following: (a) For theories where all right-handed quarks are singlets under weak isospin, the existence of quarks with different values of T/sub L/^{2} and Y/sub L/ implies one or more conservation laws in addition to charge. (b) In models with quarks of charges 2/3 and -1/3 and no new conservation laws we find that there are only three possibilities: (i) a generalization of the standard model with left-handed doublets and right-handed singlets, (ii) its mirror image, and (iii) a pure vector model with all quarks in doublets on the right and on the left, with degenerate masses for quarks of the same charge.

55282 Orientation of the weak interaction with respect to the strong interaction. Wilczek, F.; Zee, A. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). *Phys. Rev., D;* **15**: No. 12, 3701-3710(15 Jun 1977).

It is proposed that angles such as the Cabibbo angle and other angles which exist in theories with many quark flavors are calculable in theories where the quark mass spectrum is spontaneously determined by the strong interaction. Some simple model calculations of this type are presented. The mechanism is tested in a two-dimensional model where all our approximations may be made arbitrarily good. Four-dimensional, quasirealistic calculations are presented, including some models which lead to nonzero mixing angles. Two distinct stages in the determination of weak-interaction angles are identified and the relationship between them is explored.

STRONG INTERACTIONS, GENERAL

55283 Factorization of Regge slopes for ordinary and new hadrons. Igi, K. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). *Phys. Lett., B;* **66**: No. 3, 276-278(31 Jan 1977).

The author proposes a factorization property of Regge slopes between ordinary and new hadrons. Three (six) relations for bosons (baryons) are derived. This is supported experimentally in a known case and several predictions are made. The D** mass is predicted to be 2.36 GeV.

55284 Quark sea and quantum chromodynamics. Donoghue, J.F.; Golowich, E. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., D;* **15**: No. 11, 3421-3432(1 Jun 1977).

Employing a quantum-chromodynamic framework, we study the existence of quark-antiquark pairs, in addition to the usual valence quarks, within the rest frame of baryons. The structure of such a quark sea is discussed and an estimate of its strength is made using the MIT bag model. A significant amount of sea is found, and its effect on calculated properties of hadrons is 20—30%.

55285 G parity and the breaking of exchange degeneracy. Chew, G.F.; Rosenzweig, C. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., D;* **15**: No. 11, 3433-3440(1 Jun 1977).

Exact exchange degeneracy, a property of the planar S matrix, is not a feature of the physical world. G parity, an exact symmetry of strong interactions, fails to be maintained by the discontinuities of the planar S matrix. This paper examines the connection between these two conflicting concepts and shows how calculations of exchange-degeneracy breaking may be based on G parity. The relation of G parity to the cylinder and torus components of the topological expansion is a central feature. We apply our arguments to rho-A_3 splitting and justify the use of an unsubtracted dispersion relation for α/sub A_3/ - α/sub rho/. Our analysis of the dispersion relation reveals a dominant role for the $\pi\pi$ channel.

STRONG INTERACTIONS, BARYON NO.=0

55286 (UH—511-234-77) **Decays involving scalar Higgs particles.** Ma, E.; Pakvassa, S.; Tuan, S.F. (Hawaii Univ., Honolulu (USA). Dept. of Physics and Astronomy). Apr 1977. Contract EY-76-S-03-0511. 5p. Dep. NTIS, PC A02/MF A01.

Decays from charm particles and psions involving possible Higgs scalars (H/sup +-/, H^0) in final state are examined.

55287 **psi decays into baryon pairs.** Mtingwa, S.K. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Phys. Rev., D;* **15**: No. 11, 3346-3353(1 Jun 1977).

We discuss the decays of psi into octet-baryon—antibaryon pairs using a model due to Okubo wherein psi decays into uncharmed hadrons via its couplings to both hadronic and electromagnetic currents with appreciable interference effects. Relations are derived for the baryon form factors in terms of the nucleon electromagnetic form factors. As a model for the nucleon electromagnetic form factors we use a Veneziano-type dual current model subject to the Drell-Yan constraints and the Okubo-Zweig-Iizuka rule. Branching ratios are computed and comparisons are made to other form-factor models.

55288 **Meson spectrum in the quark model with a phenomenological potential.** Wills, J.G.; Lichtenberg, D.B.; Kiehl, J.T. (Physics Department, Indiana University, Bloomington, Indiana 47401). *Phys. Rev., D;* **15**: No. 11, 3358-3365(1 Jun 1977).

The masses of mesons are calculated under the assumption that meson is a bound state of a quark-antiquark pair interacting via a phenomenological potential. The form of the potential, which contains a Coulomb-type term, a linear confining term, pulse spin-orbit, tensor, spin-spin, and other terms, is suggested by gauge field theoty, but the magnitudes of the terms are determined by phenomenological fit to the data. Predictions are given for the masses of as yet unseen mesons.

STRONG INTERACTIONS, BARYON NO.=1

55289 **Status of the Regge-pole model for KN scattering.** Joynson, D.; Kang, K.; Nicolescu, B. (Department of Physics and Astronomy, University College, London, England). *Phys. Rev., D;* **15**: No. 11, 3296-3308(1 Jun 1977).

We compare the data on K^+-p elastic, KN charge-exchange, and π^-p yields eta^{0}n scattering with several classes of models. We show that the simple Regge-pole model is surprisingly good except for certain discrepancies with the data in and near the forward direction. It is found that if we add high-energy terms of a quadratic form in logs to all exchanges while at the same time imposing certain desirable restrictions (for example exchange degeneracy) on the Regge-pole parameters, an accurate description of the data can be obtained. Polarization predictions at high energy clearly distinguish between the different types of model, and KN charge-exchange and eta^0 production are shown to offer the best test of the existence of these unconventional effects near $t = 0$.

55290 **Problems with the normalization of cross sections in the constituent-interchange model.** Pire, B. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **15**: No. 11, 3475-3477(1 Jun 1977).

It is in principle straightforward to estimate the size of differential cross sections at wide angle in parton models. We show in this note that such estimations in the framework of the constituent-interchange model disagree completely with experimental data.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

55291 **Relativistic interactions between nuclei.** Schmidt, I.A.; Blankenbecler, R. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **15**: No. 11, 3321-3331(1 Jun 1977).

A relativistic theory of the inclusive scattering of nuclei is given. The theory is applicable to meson production reactions as well as to the yields of light nuclei. A characterization of the relativistic nuclear wave function is given and its connection to the standard wave function is explicitly shown. Counting rules are derived that allow one to characterize the behavior of the reaction cross sections simply in terms of the short-range behavior of the nucleon-nucleon force. Good agreement with experiment is achieved if the force is assumed to be due to the exchange of vector mesons with monopole form factors at each vertex. The predictions are successfully compared to several reactions.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

55292 **Three simple classes of mixing models.** Bolzan, J.F.; Palmer, W.F.; Pinsky, S.S. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). *Phys. Rev., D;* **15**: No. 11, 3460-3465(1 Jun 1977).

Three classes of mixing models are examined with respect to mass constraints and Okubo-Zweig-Iizuka rule violation.

55293 **SU(6) classification for "in" and "out" states.** Fuchs, N.H. (Department of Physics, Purdue University, West Lafayette, Indiana 47907). *Phys. Rev., D;* **15**: No. 12, 3717-3723(15 Jun 1977).

Within the context of the quark model with interaction, SU(6) algebras classifying "in" and "out" states are constructed and the unitary transformation relating these algebras to the SU(6)/sub W ,/ algebra generated by integrals of local currents is given simply. The formulation is general so that one may study kinematic effects, which arise even in the absence of interaction from the angular requirements on the generators of the classification algebras, separate from dynamical effects, which are peculiar to the nature of the interaction and are also induced by these angular constraints.

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

55294 (UH—511-235-77) **Eigenvalue condition for the Weinberg angle and possible new leptons and quarks.** Ma, E. (Hawaii Univ., Honolulu (USA). Dept. of Physics and Astronomy). Apr 1977. Contract EY-76-S-03-0511. 8p. NTIS, PC A02/MF A01.

In a given SU(2) x U(1) gauge model of the weak and electromagnetic interactions, if one assumes that an eigenvalue condition exists for the mixing (Weinberg) angle, then its value can be computed in lowest-order perturbation theory. This idea is illustrated with several examples, including two which are in agreement with all the present available data.

55295 **Fermion masses in gauge theories with chiral invariance at short distances.** Ansel'm, A.A.; D'yakonov, D.I. (Leningrad Institute for Nuclear Physics, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **44**: No. 4, 663-671(Oct 1976).

If one imposes chiral invariance at short distances on gauge theories with spontaneous symmetry breaking of the Higgs type one obtains a natural mechanism for the appearance of two classes of fermion masses: light ones and heavy ones. The light fermion masses turn out to be of the order g^2 times the masses of the heavy ones, g being the gauge coupling constant. The possibility of imposing chiral invariance is based on a nontrivial property of the renormalization of the Yukawa coupling constants in gauge theories. As an illustration a simple SU (3) lepton model is considered in which the ratio of the electron and muon masses can be calculated to be of order 1/137.

APPLICATIONS TO STRONG INTERACTIONS

55296 (UH—511-233-77) **Consequences of the Okun-Zakharov-Pontecorvo model of CP nonconservation.** Pakvasa, S.; Tuan, S.F. (Hawaii Univ., Honolulu (USA). Dept. of Physics and Astronomy). Apr 1977. Contract EY-76-S-03-0511. 5p. Dep. NTIS, PC A02/MF A01.

The consequences of a recent speculation that there might exist a milli-strong C-violating but P-conserving interaction in the decays of charmed particles are explored. The decays of β, K$_o$/sub L/, ω^0, eta^0, and psi are discussed. 7 references. (JFP)

55297 **Broken SU(4) symmetry and the baryon resonances.** Campbell, G. Jr. (Department of Physics, Syracuse University, Syracuse, New York 13210). *Phys. Rev., D;* **15**: No. 11, 3377-3387(1 Jun 1977).

The J/sup P/ = $3/2^+$ baryon-resonance mass spectrum, including the charmed states, and the resonance widths are calculated using a broken-SU(4) -symmetric one-baryon-exchange model of the baryon—pseudoscalar-meson forces. The dispersion-theoretic multichannel N/D matrix method is employed to construct the scattering amplitude for each state. The parameters of the theory are a mixing parameter analogous to the SU(3) F to D ratio, the mass of the exchanged baryon, a subtraction-point energy in the dispersion integrals, and the $1/2^+$ baryon and pseudoscalar-meson masses including those with nonzero values of charm. The positions and widths are determined for three different sets of predicted masses for those charmed particles.

FIELD THEORY

55298 Electromagnetic fields as a manifestation of the geometry of three-dimensional Riemannian spaces of the second class of imbedding. Bryushinkin, S.M. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. Phys. - Dokl. (Engl. Transl.);* **22**: No. 1, 26-27(Jan 1977).

A geometrical basis is provided for the five-dimensional theory of Kaluza.(AIP)

55299 Quantum chromodynamics in two dimensions. Patrascioiu, A. (Department of Physics, B-019, University of California: San Diego, La Jolla, California 92093). *Phys. Rev., D;* **15**: No. 12, 3592-3596(15 Jun 1977).

It is conjectured that the SU(N) gauge theory in two dimensions possesses two phases. Arguments in support of the existence of a new phase are presented.

55300 Surface medication for gauge theories in two dimensions. Halpern, M.B.; Senjanovic, P. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., D;* **15**: No. 12, 3629-3640(15 Jun 1977).

When surface terms cannot be neglected, the usual canonical formalism is plagued by a host of ambiguities and inconsistencies. We review these problems in the context of the massive Schwinger model, and present a complete cure effected by a well-chosen dynamical surface term. In the presence of the surface term, the canonical formulation can again be naive. We also offer an introductory application of the method to the non-Abelian case: In a box, only singlet states are possible. The "new" singlet states involve surface excitation and may not survive the large-box limit.

55301 Radially separated monopole solutions in non-Abelian gauge models. Michel, L.; O'Raifeartaigh, L.; Wali, K.C. (Institut des Hautes Etudes Scientifiques Bures-sur-Yvette, 91440, France). *Phys. Rev., D;* **15**: No. 12, 3641-3655(15 Jun 1977).

We consider a Yang-Mills-Higgs Lagrangian invariant under local gauge transformations belonging to an arbitrary compact group G. The Higgs fields are assumed to belong to a real representation of G. We analyze in detail the conditions imposed on the fields due to the requirement that the static Hamiltonian or the total energy of the system be finite. We then seek static finite-energy solutions for which the radial dependence of the fields is factorized. We show that for the coupled system of nonlinear equations emerging from the Lagrangian the equations for angular functions which carry the internal-symmetry labels and the equations for the radial functions separate into two separate systems of coupled nonlinear equations. We solve the equations for angular functions completely and show that the gauge fields vanish outside a fixed SO(3) subgroup of G and that inside the SO(3) group they reduce to the 't Hooft—Polyakov solution withunit magnetic charge in appropriate units. The Higgs fields may belong to any integer representation of this SO(3) group. The static Hamiltonian and consequently the total energy or mass of the monopole depend on the representation of the Higgs field. Thus we obtain in principle a mass formula for the monopoles, the one with the lowest mass corresponding to the 't Hooft—Polyakov case.

55302 Interpretation of pseudoparticles in physical gauges. Bernard, C.W.; Weinberg, E.J. (Columbia University, New York, New York 10027). *Phys. Rev., D;* **15**: No. 12, 3656-3659(15 Jun 1977).

The effects of pseudoparticle solutions to Yang-Mills field theories are discussed for gauges where the F/sub μ//sub ν/ uniquely determine the potentials. Even though a unique vacuum is found, the physical consequences obtained by previous authors are shown to occur. It is then shown how the $A_0 = 0$ gauge may be reformulated to give a unique vacuum. The many vacuums found by previous authors are seen to be artifacts of a particular parametrization of function space.

55303 Flux quantization and angular momentum in non-Abelian gauge field theories. Huang, K.; Stump, D.R. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **15**: No. 12, 3660-3667(15 Jun 1977).

We study a Yang-Mills field, with gauge group generators L/sub a/ (a = 1, . . . ,n), coupled to self-interacting source fields through a gauge coupling constant e. The following results are obtained: (a) The total angular momentum, defined as Poincare group generators, is the free-field angular momentum plus $(1/2\pi)$ Q/sub a/Phi-arrow-right/sub a/, where Q/sub a/ is the total charge and Phi/sup k//sub a/ is the total flux of Δ x A/sub a/ in the x/sup k/ direction. (b) There is a choice of {L/sub a/} such that the flux matrix Phi-arrow-right equivalent Phi-arrow-right/sub a/L/sub a/ obeys the quantization condition $[(e/2\pi)\,\mathrm{Phi}^1,(e/2\pi)\,\mathrm{Phi}^2] = (ie/2\pi)\,\mathrm{Phi}^3$. (c) $(e/2\pi)$ Phi-arrow-right generates gauge transformations that are equivalent to spatial rotations of asymptotic Higgs fields. (d) For any solution in which $(e/2\pi)$ Phi-arrow-right not-equal 0, the gauge field is a monopole field with pole strength g = 1/e.

55304 Resonances in SU(2) gauge theory. Stern, A. (Physics Department, Syracuse University, Syracuse, New York 13210). *Phys. Rev., D;* **15**: No. 12, 3672-3674(15 Jun 1977).

Classical periodic trajectories are shown to exist for a test particle moving in an external SU(2) gauge field. The field is assumed to be static and of the form proposed by Wu and Yang. The energy of the system is positive, so the orbits are expected to give rise to a spectrum of metastable states. A Bohr-Sommerfeld quantization scheme is proposed for finding the spectrum. The results are applied to the problem of a particle interacting with a Polyakov-'t Hooft monopole, via the explicit solution of Prasad and Sommerfield.

55305 Consistency of SU(N) gauge theory in two Euclidean dimensions. Hanson, A.J.; Prasad, M.K. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., D;* **15**: No. 12, 3765-3767(15 Jun 1977).

We examine the consistency of an SU(N) quark-gluon gauge theory in two Euclidean spacetime dimensions. Using Lorentz-invariant quantization surfaces, an axial gauge, the 1/N expansion, and the analog of a principal-value infrared cutoff, we solve exactly the Dyson self-dimension equation for a quark with zero bare mass. We thus evade the inconsistency present in the timelike-gauge Minkowski-space approach to the theory.

55306 Quantum meaning of classical field theory. Jackiw, R. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Rev. Mod. Phys.;* **49**: No. 3, 681-706(Jul 1977).

Recent researches have shown that it is possible to obtain information about the physical content of nontrivial quantum field theories by semiclassical methods. This article reviews some of these investigations. We discuss how solutions to field equations, treated as classical, c-number nonlinear differential equations, expose unexpected states in the quantal Hilbert space with novel quantum numbers which arise from topological properties of the classical field configuration or from the mixing of internal and space-time symmetries. Also imaginary-time, c-number solutions are reviewed. It is shown that they provide nonperturbative information about the vacuum sector of the quantum theory.

SCATTERING THEORY

55307 Wavepacket scattering in potential theory. Weber, T.A.; Hammer, C.L. (Ames Laboratory-ERDA and Department of Physics, Iowa State University, Ames, Iowa 50011). *J. Math. Phys. (N.Y.);* **18**: No. 8, 1562-1567(Aug 1977).

A contour integration technique is developed which enforces the initial conditions for wavepacket-potential scattering. The expansion coefficients for the exact energy eigenstate expansion are automatically expressed in terms of the plane wave expansion coefficients of the initial wavepacket, thereby simplifying what is usually a tedious, mathematical process. The method is applicable regardless of the initial spatial separation of the wavepacket from the scattering center.

EXPERIMENTAL TECHNIQUES

55308 Program for calculating gamma—gamma directional correlation coefficients and mixing ratios. Macias, E.S. (Washington Univ., St. Louis); Ruhter, W.D.; Camp, D.C.; Lanier, R.G. *Comput. Phys. Commun.;* **11**: 75-93(1976).

The program ANGCOR has two modes of operation: in the first mode, directional correlation coefficients are determined by least-squares fits to the experimental data with second- and fourth-order Legendre polynomials having only even terms. The coefficients are then corrected for the experimental finite solid angles. For each spin sequence entered, a chi-square value is calculated for 49 possible values of each transition mixing ratio. The printout appears as a 49 by 49 point grid which resembles a contour map. A study of several of these printouts allows the user to qualitatively determine possible spin sequences and mixing ratios. Mode II, the data simulation mode, calculates a set of directional correlation coefficients from spins and mixing ratios entered, corrects for solid angle, and calculates a set of angular correlation data normalized to A_0 = 10,000. The required inputs are spin assignments for the three levels, mixing ratios of the transitions, and the experimental solid-angle corrections. The second mode allows tests of the program or examination of results for given spin sequences and mixing ratios. An option in both modes magnifies any section of the X^2 grid. Input must be ten angles or fewer. Correlations are limited to successive gamma-ray cascades. The program is written in FORTRAN IV and requires 25 344 memory locations. Running time depends on the computer used and the number of angles entered. Seven angles and

one spin sequence require ls on a CDC 7600. 3 figures, 1 table (RWR).

55309 **Future directions for sensitivity-based cross-section data assessment.** Weisbin, C.R.; Oblow, E.M.; Marable, J.H. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 483-484(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55310 **Data covariance estimation methods for sensitivity-based data assessment.** Muir, D.W. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 484-485(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

55311 **Experience with quantitative data assessment and results for fusion reactors.** Gerstl, S.A.W.; Dudziak, D.J.; Muir, D.W. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 482-483(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

REFER ALSO TO CITATION(S) 55313, 55522

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 55313

55312 **Assessment and evaluation of sodium cross sections on the basis of integral flux measurements.** Parvez, A.; Becker, M. (Rensselaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.;* **26**: 594-595(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

55313 (EURFNR—1419) **Evaluations for the German nuclear data library KEDAK-3. Part 1. Non-fissile materials.** Goel, B. (comp.). (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Mar 1977. 183p. (KFK—2389/2). Dep. NTIS (US Sales Only), PC A09/MF A01.

Work performed under United States—Euratom Fast Reactor Exchange Program.

Evaluations for the KEDAK-3 library performed between 1970 and 1976 are discussed. In particular, the data changes for the materials H, D, ^{12}C, ^{16}O, ^{27}Al, ^{23}Na, Mo, Cr, Fe, and Ni are described. 95 figures, 28 tables, 172 references.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 55313

55314 **^{59}Co + n calculations up to neutron energies of 40 MeV.** Young, P.G.; Arthur, E.D. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 503-504(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, THEORETICAL

REFER ALSO TO CITATION(S) 55331

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 55316

55315 **Evaluated nuclear structure data file (ENSDF) for basic and applied research.** Ewbank, W.B. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **26**: 566-567(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 55313

55316 **Neutron capture cross-section measurements of ^{99}Tc up to 80 keV.** Little, R.C.; Block, R.C. (Rensselaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.;* **26**: 574-575(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

SPONTANEOUS AND INDUCED FISSION

55317 **Singularities of the fissility of nuclei of medium-heavy elements.** Andronenko, L.N.; Vaishene, L.A.; Gorshkov, V.L.; Koshevnyi, G.G.; Kotov, A.A.; Semenchuk, G.G.; Solyakin, G.E. (B. P. Konstantinov Institute of Nuclear Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **24**: No. 11, 573-581(5 Dec 1976).

We present experimental data on the fissility of nuclei from U to Sm, which reveal a singularity, in the region of the rare-earth elements, of the fissility as a function of the parameter Z^2/A of the target.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

REFER ALSO TO CITATION(S) 55317

SPONTANEOUS AND INDUCED FISSION

55318 (LA-NUREG—6818-MS) **FPDCYS and FPSPEC: computer programs for calculating fission-product beta and gamma multigroup spectra from ENDF/B-IV data.** Stamatelatos, M.G.; England, T.R. (Los Alamos Scientific Lab., N.Mex. (USA)). May 1977. Contract W-7405-ENG-36. 82p. Dep. NTIS, PC A05/MF A01.

FPDCYS and FPSPEC are two FORTRAN computer programs used at the Los Alamos Scientific Laboratory (LASL), in conjunction with the CINDER-10 program, for calculating cumulative fission-product beta and/or gamma multigroup spectra in arbitrary energy structures, and for arbitrary neutron irradiation periods and cooling times. FPDCYS processes ENDF/B-IV fission-product decay energy data to generate multigroup beta and gamma spectra from individual ENDF/B-IV fission-product nuclides. FPSPEC further uses these spectra and the corresponding nuclide activities calculated by the CINDER-10 code to produce cumulative beta and gamma spectra in the same energy grids in which FPDCYS generates individual isotope decay spectra. The code system consisting of CINDER-10, FPDCYS, and FPSPEC has been used for comparisons with experimental spectra and continues to be used at LASL for generating spectra in special user-oriented group structures. 3 figures.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

55319 (EURFNR—1436) **Evaluations for the German nuclear data library KEDAK-3. Part 2. Fissile and fertile materials.** Goel, B.; Weller, F. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Mar 1977. 79p. (KFK—2386/3). Dep. NTIS (US Sales Only), PC A05/MF A01.

Work performed under United States—Euratom Fast Reactor Exchange Program.

Evaluations for the fissile and fertile isotopes performed at KFK during the years 1973 to 1976 are presented. In particular, the evaluations of the data for ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, and ^{241}Pu are described. Results of a preliminary check of the evaluated data for a variety of critical assemblies are also given. 37 figures, 16 tables, 177 references.

55320 **Evaluation of the ^{239}Pu neutron data for ENDF/B-V.** Kujawski, E. (General Electric Co., Sunnyvale, CA); Stewart, L. *Trans. Am. Nucl. Soc.;* **26**: 591(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55321 **Evaluation of ^{238}U for ENDF/B-V.** Pennington, E.M.; Poenitz, W.P.; Smith, A.B. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 591-592(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 55319, 55320, 55321

55322 **Fission cross sections of ^{235}U and ^{239}Pu averaged over ^{252}Cf neutron spectrum.** Davis, M.C.; Knoll, G.F. (Univ. of Michigan, Ann Arbor). *Trans. Am. Nucl. Soc.;* **26**: 595-596(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

NUCLEAR THEORY

NUCLEAR REACTIONS AND SCATTERING

55323 **Empirical formulas for 14-MeV neutron-induced cross sections.** Pai, H.L.; Andrews, D.G. (Univ. of Toronto). *Trans. Am. Nucl. Soc.;* **26**: 569(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 54810, 55335

55324 (SAND—77-0832) **SPHERE: a spherical-geometry multimaterial electron/photon Monte Carlo transport code.** Halbleib, J.A. Sr. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 31p. Dep. NTIS, PC A03/MF A01.

SPHERE provides experimenters and theorists with a method for the routine solution of coupled electron/photon transport through multimaterial configurations possessing spherical symmetry. Emphasis is placed upon operational simplicity without sacrificing the rigor of the model. SPHERE combines condensed-history electron Monte Carlo with conventional single-scattering photon Monte Carlo in order to describe the transport of all generations of particles from several MeV down to 1.0 and 10.0 keV for electrons and photons, respectively. The model is more accurate at the higher energies, with a less rigorous description of the particle cascade at energies where the shell structure of the transport media becomes important. Flexibility of construction permits the user to tailor the model to specific applications and to extend the capabilities of the model to more sophisticated applications through relatively simple update procedures. 8 figs., 3 tables.

55325 **Matrix methods for radiation transport.** Aronson, R. (Polytechnical Inst. of New York, Brooklyn). *Trans. Am. Nucl. Soc.;* **26**: 476(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55326 **Simultaneous measurement of neutron and gamma-ray spectra in tissue equivalent medium.** Stupar, T.A.; Elson, H.R.; Shapiro, A.; Kereiakes, J.G. (Univ. of Cincinnati, Ohio). *Trans. Am. Nucl. Soc.;* **26**: 489-491(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55327 **Improved multigroup Monte Carlo photon cross-section technique.** Scudiere, M.B.; Ward, J.T. Jr. (Univ. of Virginia, Charlottesville). *Trans. Am. Nucl. Soc.;* **26**: 496-497(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55328 **Rejection technique for selecting photon scattering angles in MORSE.** Ward, J.T. Jr. (Univ. of Virginia, Charlottesville). *Trans. Am. Nucl. Soc.;* **26**: 497-498(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55329 **Energy losses by slow ions and atoms to electronic excitation in solids.** Ferrell, T.L.; Ritchie, R.H. (Physics Department, Appalachian State University, Boone, North Carolina 28608). *Phys. Rev., B;* **16**: No. 1, 115-123(1 Jul 1977).

We consider the theory of energy losses by slow ions and atoms to electronic excitations in an electron gas. Predictions of the theory are compared with experimental data on ion penetration in several different solids. We also compare the stopping power obtained from linear-response theory with that found from numerically computed phase shifts for electron scattering on the screened potential of an ion. The stopping power of an electron gas for slow, singly ionized He atoms is calculated from linear-response theory, by using a wave function for the bound electron determined self-consistently in the electron gas.

SHIELDING CALCULATIONS AND EXPERIMENTS

REFER ALSO TO CITATION(S) 54493, 54494, 55325, 55337, 55340, 55545

55330 **Recent radiation transport methods development at Los Alamos Scientific Laboratory.** Miller, W.F. Jr. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 473-474(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55331 **What you should know about ENDF/B-V.** Dunford, C.; Kinsey, R. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 480(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55332 **Effects of lead shields on neutron spectra.** Eccleston, G.W.; Woodruff, G.L. (Univ. of Washington, Seattle). *Trans. Am. Nucl. Soc.;* **26**: 537-538(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55333 **Radiation shielding information center: an international technology resource.** Maskewitz, B.F.; Trubey, D.K.; Roussin, R.W.; McGill, B.L. (Radiation Shielding Information Center, Oak Rdige, TN). *Trans. Am. Nucl. Soc.;* **26**: 563-566(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 54283, 54408, 54409, 54464, 54465, 54466, 54468, 54470, 54471, 54473, 54474, 54560, 55310, 55325, 55326

55334 **Theoretical and computational analysis of two-group integral transport equation for finite spherical and cylindrical media.** Lee, U.C. College Park, MD; Univ. of Maryland (1976). 195p. University Microfilms Order No. 77-10,407.

Thesis (Ph. D.).

An analytical procedure has been developed to solve two-group transport problems in cylindrical and spherical one-dimensional finite geometries. Both first and second order transform proce-

dures are utilized to reduce the two-group integral transport equation to a form which can be solved using the method of singular eigenfunction expansion. The applications to specific examples include the spherical shell-source problem, the cylindrical critical problem and the cylindrical shell-source problem. In order to explore a more universal procedure of dealing with convex geometries, a second-order transform technique is discussed diversely. With application to both sperhical and cylindrical geometries, this procedure is demonstrated to be equivalent to the more specialized first-order transform procedure applicable only to spherical problems. A numerical algorithm for the spherical shell-source problem is incorporated in a computer code, TWOSS. The total neutron densities, angular flux, net current and macroscopic neutron balance can be obtained from this computation. The accuracy of TWOSS is investigated by a comparison of the total flux with the values obtained using a discrete ordinates code ANISN. Agreement was achieved to within the numerical accuracy of the model. Also the advantage of TWOSS over a discrete ordinates calculation is demonstrated since the contribution to the density from the discrete and continuous eigenfunctions is shown separately. Since the discrete solution closely approximates the diffusion theory, the errors incurred near the sources and boundaries in using the diffusion approximation are readily quantified.

55335 Finite element methods for radiation transport calculations. Lewis, E.E. (Northwestern Univ., Evanston, IL). *Trans. Am. Nucl. Soc.;* **26**: 474-475(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55336 Discrete angle, finite element formulation. Lillie, R.A. (Oak Ridge National Lab., TN); Robinson, J.C. *Trans. Am. Nucl. Soc.;* **26**: 475-476(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55337 New concept for deep-penetration transport calculations and two new forms of the neutron transport equation. Gerstl, S.A.W. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 476-477(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55338 Roles of the event value and the point value in Monte Carlo importance sampling. Tang, J.S. (Oak Ridge National Lab., TN); Hoffman, T.J.; Stevens, P.N. *Trans. Am. Nucl. Soc.;* **26**: 477-478(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55339 Computational method for toroidal geometry effects. Jung, J. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 478-479(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55340 National neutron cross-section center. Pearlstein, S. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **26**: 566(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55341 Relation between Chandrasekhar's x-function and the eigenvalues of integral operators with difference kernels. Rao, R.V. (Indian Inst. of Science, Bangalore). *J. Math. Anal. Appl.;* **59**: No. 1, 60-68(1 Jun 1977).

The spectral analysis of integral operators with difference kernels on finite intervals plays an important role in a wide class of transport phenomena such as neutron transport and radiative transfer. In the semi-infinite case, it can be shown that the eigenvalues for these operators can be related to the poles and zeros of what is usually referred to as the H-function of Chandrasekhar. A rigorous proof of the relation between the poles and zeros of the X function (corresponding to the H function) and the eigenvalues is given. This is done in two steps. First differentiability property of the resolvent kernel is proven and then, using this property, and an identity involving the X function and the resolvent kernel is proven. This identity in turn would relate the X function to the eigenvalues by an earlier result. 5 refs. (JFP)

MEDICAL PHYSICS

DOSIMETRY

55342 Calculation of dose from high-energy electrons. Seltzer, S.M. (National Bureau of Standards, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 499-501(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55343 Dosimetry in tissue-equivalent phantoms exposed to high-energy electrons: from cavity theory to Monte Carlo. O'Brien, K. (Energy Research and Development Administration, New York). *Trans. Am. Nucl. Soc.;* **26**: 501-502(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

SOLID STATE PHYSICS

55344 Correlations between the structure and reactivity at solid-gas and solid-liquid interfaces. Somorjai, G.A. (Univ. of California, Berkeley). *J. Electrochem. Soc.;* **124**: No. 6, 205C-214C(Jun 1977).

Recent developments indicate that new understanding of electrode processes and chemical phenomena which take place at the solid-liquid interface will come from correlations with studies of equivalent processes at the solid-gas interface. Present views of the atomic and electronic structure of surfaces and adsorbates are reviewed, along with the surface composition of binary alloy systems as it emerges from modern studies of the solid-vacuum and solid-gas interfaces. Then some of the surface reaction studies which have been carried out recently to correlate the reactivity of the surface with its structure and composition are reviewed. Finally, certain research projects which would be of importance to begin to correlate surface phenomena at solid-liquid and solid-gas interfaces are proposed. 10 figures, 4 tables (RWR)

55345 Calculations of the thermal boundary resistance. Katerberg, J.A.; Reynolds, C.L. Jr.; Anderson, A.C. (Department of Physics and Materials Research Laboratory, University of Illinois, Urbana, Illinois 61801). *Phys. Rev., B;* **16**: No. 2, 673-679(15 Jul 1977).

A comparison is made of two versions of the acoustic-mismatch theory of the thermal boundary resistance R which occurs at the interface between a pair of solids. The most recent version predicts R yields 0 as the two solids become identical, while the earlier version indicates a finite R as the interface essentially vanishes. It is shown that the two versions make different assumptions as to what a thermometer measures and that, if appropriate thermometers are used, both versions give the same result. This conclusion is supported by experimental evidence.

55346 Simplified kinetic theories for electron-hole condensation. Silver, R.N. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., B;* **16**: No. 2, 797-800(15 Jul 1977).

It is shown that expressions for electron-hole droplet nucleation and decay currents, derived in earlier papers by the author and others, can be applied to problems of time-dependent exciton densities only in restricted conditions. The induction time, which characterizes the response of nucleation and decay currents to changes in the exciton density, must be shorter than the inverse logarithmic time derivative of the nucleation and decay currents when these are significant. Numerical studies show that the induction time is too long for steeply rising high-intensity pulses, and for most decay phenomena except for extremely slow changes in the laser intensity.

SOLID STATE PLASMA

55347 Ultrafast transient response of solid-state plasmas. I. Germanium, theory, and experiment. Elci, A.; Scully, M.O.; Smirl, A.L.; Matter, J.C. (Department of Physics and Optical Sciences Center, University of Arizona, Tucson, Arizona 85721). *Phys. Rev., B;* **16**: No. 1, 191-221(1 Jul 1977).

A first-principles theory is developed for the generation and the subsequent transient behavior of dense electron-hole plasmas produced in germanium by intense picosecond optical pulses. Experimental data are discussed and compared with the theory. It is shown that the valley structure of the Ge conduction band, phonons, and plasmons play significant roles in the generation and the temporal evolution of the plasma. The agreement between the theory and experiments is good. Some predictions of the theory are discussed.

SUPERCONDUCTIVITY

55348 (COO—2271-98) **High-temperature series expansions for isotropic Heisenberg model in one and two dimensions:** I. Gujrati, P.D. (Columbia Univ., New York (USA). Dept. of Physics). 1974. Contract EY-76-C-02-2271. 49p. Dep. NTIS, PC A03/MF A01.

This preliminary report considers all the clusters with n less than or equal to 10 and l less than or equal to 10 on a regular square lattice and uses the representations of the symmetric group to calculate their partition functions as a series in powers of the reciprocal temperature 1/T up to twentieth order. The contribution of these clusters to the free energy are computed for the infinite regular square lattice in zero external magnetic field. The contribution of the external field can be calculated exactly to any desired power in the reciprocal temperature. This calculation is carried out for the linear lattice. The complete contribution to twentieth order for an infinite square lattice must include graphs that cover remaining clusters up to n = 20 and l = 20. The contributions of these graphs will be found in a subsequent publication. However, the expression for the linear lattice is complete. It should be mentioned that the computations are completely free of rounding errors. 4 figs., 3 tables.

GENERAL THEORY

55349 Features of the phase transition in nonequilibrium superconductors with optical pumping. Elesin, V.F. (Moscow Engineering-Physics Institute). *Sov. Phys. - JETP (Engl. Transl.);* **44**: No. 4, 780-786(Oct 1976).

The behavior of a nonequilibrium superconductor near the phase-transition point is investigated. Nonequilibrium quasi-particles are created as a result of absorption of an electromagnetic field with frequency considerably greater than the superconducting gap. The energy distribution of the quasi-particles at zero temperature and at temperatures close to the transition temperature is studied by means of the kinetic equation describing the energy relaxation of the excess quasi-particles with emission of phonons. The dependence of the order parameter on the power of the source and on the temperature is found. It is shown that, above a certain critical power at a fixed temperature (or above a certain temperature at a fixed power of the source), this dependence becomes double-valued, i.e., apart from the usual solution, according to which the gap decreases with increase of pumping power, there appears a second solution, describing an increase of the gap with increased pumping. The existence of the second solution is connected with the coherent character of the interaction of the quasi-particles of the superconductor with the phonons. The stability of the state of a superconductor with optical pumping against small fluctuations is considered and it is postulated that the double-valued dependence of the order parameter on the pumping power may be responsible for the experimentally observed gradual increase in the resistivity of a superconductor with increased pumping.

55350 Forces acting on vortices moving in a pure type II superconductor. Kopnin, N.B.; Kravtsov, V.E. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **44**: No. 4, 861-867(Oct 1976).

The motion of vortices in a very pure type II superconductor is analyzed in the case κ very-much-greater-than 1 on the basis of the microscopic theory of superconductivity. It is shown that, similar to He II, the motion of the vortices is determined by the balance between the Magnus force of mutual friction between the superfluid and normal components. This latter force can be expressed in terms of the transport and transverse scattering cross sections for normal excitations on the vortex.

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 54781, 54792

THEORETICAL PHYSICS

REFER ALSO TO CITATION(S) 55341

CLASSICAL AND QUANTUM MECHANICS

55351 Possible experimental test of local commutativity. Benioff, P.; Ekstein, H. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **15**: No. 12, 3563-3567(15 Jun 1977).

A direct experimental test for local commutativity (i.e., [A,B] = 0 if A and B are associated with mutually spacelike regions) is proposed. It consists of a comparison of the distribution of outcomes of A measurements in the two cases where A alone is measured (no measurement apparatus for B present) and where both are measured on the same sample, in short, a test of the compatibility of the two observation procedures for A and B. The implication compatibility yields commutativity (substantially proved by von Neumann, but questioned by Park and Margenau) is proved in a stronger form, with close attention paid to the distinction between different procedures corresponding to a given self-adjoint operator.

RELATIVITY AND GRAVITATION

55352 Symmetries of the stationary Einstein—Maxwell field equations. II. Kinnersley, W.; Chitre, D.M. (Department of Physics, Montana State University, Bozeman, Montana 59715). *J. Math. Phys. (N.Y.);* **18**: No. 8, 1538-1542(Aug 1977).

From Einstein—Maxwell fields which are stationary and axially symmetric, we show how to construct an infinite hierarchy of potentials. The potentials form a representation of K', the infinite-parameter symmetry group of the Einstein—Maxwell equations. For flat space, the hierarchy is calculated explicitly.

OPTICS

55353 Far-infrared generation by optical mixing. Shen, Y.R. (Lawrence Berkeley Lab., CA). *Prog. Quantum Electron.;* **4**: 207-232(1976).

Optical mixing is a process in which two or more optical waves interact and generate new frequency components. This review begins with a brief theoretical description of the problem and points out computational difficulties. Then the experimental observations of far-infrared generation by optical mixing in transparent crystals are discussed. Subsequent sections describe the frequency dependence of nonlinear susceptibilities and far-infrared output, theoretical extension to generation by stimulated polariton scattering (with experimental results), tunable far-infrared generation by optical mixing via spin-flip transitions, far-infrared generation by optical mixing in a crystal through optical rectification by absorbing impurities and in a metal vapor through resonantly enhanced third-order nonlinearity, and use of optical mixing as a spectroscopic technique. 14 figures, 1 table, 78 references. (RWR)

STATISTICAL PHYSICS AND THERMODYNAMICS

55354 Integral operators generated by exponential integrals. Kaper, H.G. (Argonne National Lab., IL). *J. Math. Anal. Appl.;* **59**: No. 2, 216-226(15 Jun 1977).

Some results for integral operators whose kernels are the exponential integrals are presented. In particular, their interrelations and commutativity properties with the differentiation operator, and the behavior of the image functions near the endpoints of the domain of integration, are investigated.

MATHEMATICAL PHYSICS

55355 (AD-A—038952) **Some finite dimensional integrable systems and their scattering behavior. Technical summary report.** Adler, M. (Wisconsin Univ., Madison (USA). Mathematics Research Center). Feb 1977. Contracts DAAG29-75-C-0024;N00014-76-C-0301. 74p. (MRC-TSR—1718). NTIS PCA04/MF A01.

Integrable Hamiltonian systems and also systems whose Hamiltonians are integrals of these are discussed. The derivation of the results is made possible by the fact that the equations of motion can be interpreted as deformation equations for matrix functions whose spectrum remains fixed as the system evolves in time, leading both to integrals of the motion, and a description of the solution.

55356 Numerical bifurcation and secondary bifurcation: a case history. Bauer, L.; Reiss, E.L. (New York Univ., NY). pp 443-467 of In Numerical solution of partial differential equations. III. New York; Academic Press, Inc. (1976).

Secondary transitions or secondary bifurcations occur frequently in many nonlinear stability problems. This paper describes some recent progress that has been made in the theory and numerical computation of secondary bifurcation by considering two problems for the nonlinear buckling of elastic plates, the buckled circular plate and the buckled rectangular slate. 6 figures. (RWR)

55357 Mesh refinement and local inversion of elliptic partial differential equations. Hyman, J.M. (Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Comput. Phys.;* **23**: No. 2, 124-134(Feb 1977).

A fast numerical method is developed to find an approximate solution to a general class of mildly nonlinear elliptic partial differential equations with Dirichlet boundary conditions in one, two, and three dimensions. The method is based on a local mesh refinement technique which provides an initial guess for iterative algorithms, and can be used to refine the mesh in multigrid methods.

55358 **Eigenvalues and eigenfunctions of the Hilbert operator.** Sod, G.A. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Comput. Phys.;* **23**: No. 2, 179-186(Feb 1977).

The eigenvalues and eigenfunctions of the Hilbert operator have been evaluated as part of a technique for solving Boltzmann's equation for a gas model consisting of rigid spheres. The numerical method for their evaluation is presented as well as a small sample of the results.

55359 **Prime factors of cyclotomic class numbers.** Lehmer, D.H. *Math. Comput.;* **31**: No. 138, 599-607(Apr 1977).

Let p be an odd prime. The "first factor" h (p) of the class number of the field of pth roots of unity has been the subject of many investigations beginning with Kummer (1861). In the present paper it is shown how the theory of a function introduced by T. A. Pierce (1917) can be used to find the prime factors of h (p).

55360 **Jacobi algorithm and metric theory for greatest common divisors.** Waterman, M.S. (Los Alamos Scientific Lab., NM). *J. Math. Anal. Appl.;* **59**: No. 2, 288-300(15 Jun 1977).

Greatest common divisor algorithms are used to provide a natural motivation for considering a class of Jacobi-Perron algorithms which includes the original Jacobi algorithm. This work proves convergence and establishes metric properties for one of these algorithms. The proofs generalize to the larger class of algorithms. Full connections with the calculation of greatest common divisors will be treated elsewhere.

FUSION ENERGY

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 54829, 55492

55361 (AED-Conf—76-506-013) **Heating by injection of fast neutrals and study of the ion energy balance in TFR.** (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). 1976. 9p. (In French). (IAEA-CN—35/A4-2; CONF-761012—84).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, German, Federal Republic of (F.R. Germany) (6 Oct 1976).

22 figs.; 2 tabs.; 11 refs.

In the TFR-experiment the injection of high-velocity neutral particles is quasi-perpendicular with an angle of 80° relative to the magnetic axis. With two injection lines, each consisting of five ion sources, the total extraction power reaches 2 MW and the injection power in the interior of the TFR amounts to about 650 KW. The confinement of high velocity ions, investigated starting with the spectrum of charge exchange neutrals and neutron flux, seems to be classic. The injection power, calculated for the ratios (Psub(Ni) + Psub(Ne))/Psub(E) and (Psub(Ni) + Psub(Ne))/Psub(N) by a Monte-Carlo code, amounts to about 20% and 57%, respectively. (Psub(E): extracted power, Psub(N): power of injected neutrals, Psub(Ni)(Psub(e)): power transfered to injected neutrals (electrons)). The increase in ion temperature in the central region is proportional to the energy transfered to the ions, following a law of the type $\Delta T_{sub}(i)\ (r = 0)\ (ev) = 20\ P_{sub}(Ni)\ (KW)/anti\ n_{sub}(e)\ (10^{13}\ cm^{-3})$. In the low-pressure experiments (anti nsub(e) approximately equal to $3 \times 10^{13}\ cm^{-3}$) the ion temperature increased by a factor of two and reached 1.9 KeV in the center. Two series of experiments have been analysed in particular: Injection of a deuterium beam into a deuterium plasma and injection of a hydrogen beam into a hydrogen plasma.

55362 (CEA-CONF—3733) **Report on the conference held at Grenoble (France) 28 June - 2 July 1976.** Consoli, T. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). 1976. 14p. (CONF-760958—). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 3. international symposium of plasma physics on heating in torodial devices; Varenna, Italy (6 Sep 1976).

Theoretical, experimental and technological aspects of the following topics were discussed: beam injection heating; turbulent heating; heating by electromagnetic waves; heating and refuelling of toroidal devices by laser produced plasmas; heating of large toroidal devices.

55363 (CEA-CR—10(Vol.2), pp 283-304) **Waveguide coupling of lower hybrid waves.** Brambilla, M.; Lallia, P.; Nguyen Trong Khoi (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). 1976.

From 3. international meeting on theoretical and experimental aspects of heating of toroidal plasmas; Grenoble, France (26 Jun 1976).

In Theoretical and experimental aspects of heating of toroidal plasmas. 3. International meeting, Grenoble, 28 June-2 July 1976. Vol. 2. Invited papers. Post dealing papers.

Waveguide launching of lower hybrid waves in a large Tokamak (the JET parameters were taken) using a phased waveguide array, the 'Grill', is discussed. The frequency is first chosen to locate the energy absorption region well within the plasma. The theory of the Grill is then used to define the more appropriate Grill parameters compatible with the access ports of the Tokamak. Finally, some considerations on the H.F. sources and circuit realisation in view of a heating experiment at the 10MW level are presented.

55364 (CEA-CR—10(Vol.2), pp 349-357) **Wave generation and heating of ions at ion cyclotron frequencies in tokamak-device TM-1-VCh.** Vdovin, V.L.; Shapotkovskii, N.V.; Rusanov, V.D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976.

From International conference on radial shape of nuclei; Krakow, Poland (22 Jun 1976).

In Theoretical and experimental aspects of heating of toroidal plasmas. 3. International meeting, Grenoble, 28 June-2 July 1976. Vol. 2. Invited papers. Post deadline papers.

Results on the experimental investigation of wave generation and heating of ions at the first and second harmonics of ion cyclotron frequency are reported. Cases in which small amount of resonant ions is added are also considered. A new launching system consisting of two coupling coils asymmetrically placed was designed for input power of approximately 150kW at $\omega = 2\omega_{sub}(Bi)$ and approximately 1MW at $\omega = \omega_{sub}(Bi)$. The generation efficiency experimentally observed was about 90%. Magnetosonic waves are shown to be slightly damped. The generation of such waves leads to toroidal eigenmodes whereas ion cyclotron waves are strongly damped. Small amount of resonant protons being added to deuterium plasma increases damping of m.s. waves at $\omega = \omega_{sub}(Bi)_{sup}(H)$. This results in arising a powerfull high energy tail of protons. Ion temperature increases by approximately 100eV when resonant frequencies $\omega = 2\omega_{sub}(Bi)$ and $\omega = \omega_{sub}(Bi)$ are used. Longer HF pulse cause neutral particle influx constricting the current channel which lead to MHD-instabilities.

55365 (EPRI-SR—16) **Conference proceedings: effects of cyclotron emission on the power balance in fusion systems.** Miley, G.H. (Illinois Univ., Urbana (USA)). Sep 1975. 71p. (CONF-750388—). Dep. NTIS, PC A04/MF A01.

From Conference on the effects of cyclotron emission on the power balance in fusion systems; Palo Alto, California, United States of America (USA) (3 Mar 1975).

The present workshop considered the adequacy of current theory for predicting cyclotron effects in reactor situations and the potential significance of such effects. It is concluded that experimental verification of present theories is incomplete, and continued experimental investigations are recommended. Also, some specific topics in theory such as the effect of collective phenomena on emission are suggested. Further, continued development of comprehensive codes to treat emission-transport phenomena in non-uniform plasmas with realistic geometries are encouraged. Finally, it is noted that exploratory studies of new confinement concepts that may be uniquely suited to advanced-fuel operation are needed. The recommendations are summarized in more detail.

55366 (IPP—6/147, pp v) **Numerical studies of particle confinement in high beta equilibrium mirror plasmas.** Anderson, D.V.; Johnston, B.M.; Breazeal, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

7 refs.

In Computing in plasma physics and astrophysics. Proceedings. Poster session. P 10.

Two codes have been developed to calculate 3D mirror equilibrium and to follow single particle orbits in these equilibrium fields.

55367 (IPP—6/147, pp v) **Calculation of neutral beam heating of Tokamaks.** Post, D.E.; Rutherford, P.H.; Furth, H.P.; Smith, R.R. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

2 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session G: Transport in laboratory plasmas. G 1.

A series of calculations have then been done to explore various proposed injection methods. The possible effects of an impurity driven beam deposition instability were investigated.

55368 (IPP—6/147, pp v) **Numerical simulation of neutral beam injection into a Tokamak.** Sampson, J.; Matsuda, Y.; Okuda, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

1 fig.; 4 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session B: Particle simulation in plasmas and stellar systems. B 4.

Two particle simulation codes have been developed which work on different time scales with and without including the self-consistent beam-induced microturbulence.

55369 (UCID—17458) **Recent studies concerning plasma buildup in a mirror fusion engineering research facility (FERF).** Campbell, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 May 1977. Contract W-7405-ENG-48. 18p. Dep. NTIS, PC A02/MF A01.

Use of a finite Larmor radius buildup code has resulted in revised predictions for the fusion engineering research facility (FERF) plasma. Because of charge-exchange erosion of the plasma surface, the radial density profile is found to be quite flat, in contrast to a previously predicted cubic profile. At a given value of n tau, the required beam current and the fusion neutron flux are significantly larger than previously predicted.

55370 **Doublet IIA experiments.** Freeman, R.L.; Adcock, S.J.; Baur, J.F. (General Atomic Co., San Diego, Calif. (USA)) (and others). pp 317-322 of In Plasma physics and controlled nuclear fusion research 1976. Vol. I. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

Detailed measurements of the temporal and spatial behaviour of the plasma properties of doublet, elliptic, and circular cross-section discharges in Doublet IIA have been carried out. One major result of these studies is the observation of a significant increase in the electron density, nsub(e), and the energy confinement time, tausub(E), with increased elongation. A doublet discharge with an elongation of 2.9 had an nsub(e)tausub(E) value over seven times as large as the value reported previously for a circular discharge in Doublet IIA, and it is about three times the value of an elliptic discharge with an elongation of 1.5. The elliptic and circular discharges were produced passively by controlling the plasma-induced current in the field-shaping coils surrounding the plasma. The doublet discharges were produced by actively driving selected sets of the shaping coils, and these shaping fields were adjusted in time according to the changes in the plasma current density profile which accompany plasma heating. The measured electron temperature, ion temperature, and impurity level of doublet and elliptic discharges are also presented.

55371 **Energy confinement and beta limit in the belt-pinch experiment TENQ.** Graffmann, E.; Hoenen, F.; Kaleck, A.; Koenen, L.; Schlueter, J. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Plasmaphysik). pp 351-357 of In Plasma physics and controlled nuclear fusion research 1976. Vol. I. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

In the belt-pinch experiment TENQ a stationary phase is observed, where the poloidal beta remains constant at a value of about two, indicating that the Joule heating balances the losses during this period. Prior to this phase, the poloidal beta decays rapidly from values approaching the critical beta to the equilibrium value of two. During this time interval the appearance of a reverse toroidal current near the inner edge of the plasma is observed.

55372 **Neutral-beam-driven tokamak fusion reactors.** Jassby, D.L. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). *Nucl. Fusion;* **17**: No. 2, 309-365(1977).

The ion velocity distributions of tokamak plasmas sustained by injected fast atomic beams fall into three categories, according to the partial pressure of the energetic-ion population, which in turn is determined by the plasma ntausub(E), the injection energy, and the fraction of plasma fuelling performed by the beams. There are correspondingly three regimes of beam-driven reactor operation in D-T or D-D: thermonuclear; beam-target or TCT; and plasmas with ion pressure/electron pressure much <1. This review treats the physical basis and plasma engineering parameters of beam-driven tokamak reactors. The theories of energetic-ion velocity distributions, stability, injection, and orbits are summarized. The many-faceted role of the energetic ions in plasma heating, fuelling, and current maintenance, as well as in the direct enhancement of fusion power multiplication and power density, is discussed in detail for the three reactor types. The relevant implications of recent experimental results from several beam-injected tokamaks are examined. The behaviour of energetic ions is found to be in accordance with classical theory, large total ion energy densities are readily achieved, and plasma equilibrium and gross stability are preserved. The status of neutral-beam injectors and of conceptual design studies of beam-driven reactors is reviewed briefly. The principal plasma-engineering problems are those associated directly with achieving quasi-stationary operation, particularly the problem of high-throughput particle exhaust. An especially attractive feature of beam-driven tokamak plasmas is their capability for useful application in devices of relatively small size.

55373 **Ion heating and beam trapping in the interaction of high-current electron beam with a plasma in a magnetic mirror.** Kolyada, Y.E.; Kornilov, E.A.; Fainberg, Y.B.; Kiyashko, V.S. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 1, 47-51(Jan 1977).

An experimental study is reported of ion heating and beam trapping in the interaction of a high-current electron beam with a plasma in a magnetic mirror. Intense high-frequency oscillations are excited as the beam passes through the plasma; a broad spectrum of low-frequency oscillations is also excited. These low-frequency oscillations occur near the lower hybrid frequency and the ion plasma frequency, and heat the plasma ions. When the beam interacts with the plasma part of the beam is trapped and produces a net space charge. After injection of the beam into the plasma is terminated the space charge leads to a further heating and confinement of the ions in the mirror. The experiments are carried out with an electron beam with an energy of 100—150 keV, a current of 7—12 kA, and a pulse length of 0.7—1 μsec, produced by a linear plasma betratron. The plasma ions are heated to 500 eV at a density of 5×10^{12} cm^{-3}.

55374 **Two-dimensional multi-fluid tokamak transport code.** Helton, F.J.; Miller, R.L.; Rawls, J.M. (General Atomic Company, P.O. Box 81608, San Diego, California 92138). *J. Comput. Phys.;* **24**: No. 2, 117-132(Jun 1977).

A code is presented which describes the time evolution of axisymmetric plasmas of arbitrary cross section in toroidal geometries. Assuming that flux surface shapes change more slowly than plasma parameters, transport can be regarded as proceeding through a sequence of magnetohydrodynamic equilibria. This assumption suggests an algorithm which involves iteration between one-dimensional transport calculations and two-dimensional equilibrium calculations. Numerical results pertaining to the accuracy of the code and the validity of the algorithm are presented.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 55034

55375 (EUR-CEA-FC—877) **Diagnostics used at TFR Tokamak.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Jan 1977. 46p. (In French). (CONF-761232—2). Dep. NTIS (US Sales Only), PC A03/MF A01.

From National congress on plasma physics; Paris, France (6 Dec 1976).

The methods used at the T.F.R. Tokamak (Tokamak Fontenay-aux-Roses) for determining the principal parameters of the plasma are reviewed: electron density and temperature, ion temperature, density of the neutrals in the discharge and the chemical composition of the plasma. Measurements used for determining the turbulence involved in the plasma are also discussed. All these measurements are necessary to explain the energy balance of the plasma confined in T.F.R.

55376 (JAERI-M—6662) **Measurements of Balmer H sub(α)-line emitted from tokamak plasmas in JFT-2a device.** Kasai, S.; Funahashi, A.; Sugie, T. (Japan Atomic Energy Research Inst., Tokyo). Aug 1976. 23p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Visible radiation of Balmer H sub(α)-line has been spectroscopically investigated on hydrogen tokamak plasmas in JFT-2a device with toroidal magnetic field 10 kG, plasma current 15 kA and ratio of divertor to plasma currents 1.1. The profiles of H sub(α)-line were measured on the equatorial plane horizontally along both perpendicular and tangential paths to the toroidal magnetic field, and vertically along different three paths in the minor cross-section. The typical measured profiles are interpreted in terms of the doppler broadening at line wings due to high-temperature hydrogen atoms originating through the resonance charge-exchange process and the doppler broadening at the line center due to low-temperature parti-

cles corresponding to Franck-Condon neutrals from dissociation of molecular hydrogen neutrals or ions. The peak value of doppler temperature for the hot particles is approximately 50 eV, and temperature of the cold neutrals is a few--several eV. It is noticed that equal temperatures are obtained in measurements along perpendicular and tangential directions to the toroidal magnetic field. Distributions in the minor cross-section of photon numbers of H sub(α)-line are measured, from which the confinement time of charged particles is determined to be 0.5--2.5 msec.

55377 (JAERI-M—6685) **Comparison in electron density distribution of tokamak plasma between ruby-laser scattering and millimeter wave interferometric measurements.** Matoba, T.; Funahashi, A.; Itagaki, T.; Takahashi, K.; Kumagai, K. (Japan Atomic Energy Research Inst., Tokyo). Aug 1976. 21p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The electron density in JFT-2 tokamak has been measured by two methods, i.e. Thomson scattering of ruby-laser light and interferometry of millimeter wave. Two-dimensional distribution of the scattered light intensities were obtained by scattering measurement; absolute calibration was made by normalizing the scattered intensities with the averaged density determined from interferometric measurement. The horizontal density distributions in laser scattering were compared with those in from the averaged densities measured with a 4-mm interferometer through inverse-transformation. Agreement is good between the two measurements, except where they give erroneous data because of irreproducibility of the discharge.

55378 (JAERI-M—6761) **Spectroscopic investigations of the vacuum ultra-violet emission in a normal-incidence region from JFT-2 tokamak discharge. Bsub(t) = 9 kGauss and Isub(p) = 76 kAmp.** Kasai, S.; Funahashi, A.; Tazima, T.; Nakamura, Y. (Japan Atomic Energy Research Inst., Tokyo). Oct 1976. 38p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Spectroscopic investigations have been performed in the wavelength range of 600 to 2300 A on a JFT-2 plasma with peak plasma current 76 kAmp, toroidal magnetic field 9 kGauss, and electron and ion temperature 300--350 eV and 200 eV respectively. Time-histories were measured of spectral lines radiating from oxygen and carbon impurities. The radial profiles of CV(2270.9 A) and OVII(1623.3 A) lines were measured, which showed the spatial distributions with cylindrical shells. The experimental results are compared with the theoretical ones calculated numerically by using a plasma model based on the coronal equilibrium and particle loss due to the diffusion process. Time-variation of the electron temperature during the initial phase of discharge are estimated from the measured time-histories of impurity lines, and the peak electron temperature agrees with that determined from measurements of the ruby laser scattering. The spatial distributions of CV and OVII lines are reasonably explained by the inward-diffusion flux and the diffusion flux, which is several ten times of Pfirsch-Schlueter's one.

55379 (ORNL—5275, pp 7-17) **High beta plasma section.** Dandl, R.A.; Baity, F.W.; Becker, M.C. Jun 1977.

In Fusion Energy Division annual progress report for period ending December 31, 1976.

Descriptions of research progress are given for the following topics: (1) charge-exchange spectral measurements, (2) velocity analysis of charge exchange neutrals on EBT, (3) ruby laser scattering, (4) neutral hydrogen temperature, (5) radial scans of impurity and hydrogen light, (6) x-ray diagnostics, (7) heavy ion beam probe, and (8) modeling the electron annulus in EBT from diamagnetic field and flux measurements, (9) EBT microwave systems, and (10) advanced microwave development. (MOW)

55380 **Experiments on the ATC tokamak.** Goldston, R.J.; Mazzucato, E. (Princeton Univ., N.J. (USA). Plasma Physics Lab.); Slusher, R.E.; Surko, C.M. (Bell Labs., Murray Hill, N.J. (USA)). pp 371-383 of In Plasma physics and controlled nuclear fusion research 1976. Vol. I. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

A study of electron density fluctuations in the ATC is presented, using both microwave and CO_2 laser scattering. Fluctuations are observed with wavelength between 2 cm and 0.3 mm and with frequencies up to 1.5 MHz. Their amplitude is of the order of 10^{-3}. Local measurements of the safety factor q and Zsub(eff) are also reported. The value of q was obtained from the shifts of injected ion orbits relative to the magnetic surfaces; Zsub(eff) was obtained from the scattering rate of radially localized injected ions. Both these measurements indicate a peaking of Zsub(eff) on axis. Finally, measurements of the parallel and anti-parallel fast neutral spectra are presented which indicate very different profiles for Tsub(i pan) and Tsub(i antipan).

55381 **Local measurements of impurity ions in a hydrogen plasma by an atomic-beam method.** Afrosimov, V.V.; Gladkovskii, I.P.; Kislyakov, A.I. (A. F. Ioffe Physicotechnical Institute, Academy of the Sciences of the USSR, Leningrad). *Sov. Tech. Phys. Lett. (Engl. Transl.);* 3: No. 1, 3-5(Jan 1977).

Calculations are presented concerning the possibility of using the elastic scattering of atoms as a plasma diagnostic tool. Specifically, the spectra of scattered He^+ ions in a hot H plasma is considered. (AIP).

55382 **Local measurements of electron energy spectrum in a plasma.** Altyntsev, A.T.; Krasov, V.I. (Siberian Institute of Geomagnetism, the Ionosphere, and the Propagation of Radiowaves, Siberian Branch, Academy of Sciences of the USSR, Irkutsk). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* 22: No. 1, 25-28(Jan 1977).

A procedure is described for measuring the local electron energy spectrum on the basis of the bremsstrahlung from a target in the plasma. The spatial resolution is governed by the target dimension. Measurements of the electron energy spectrum are reported for a collisionless plasma in a neutral sheet produced in a θ pinch with oppositely directed magnetic fields. The plasma heating is efficient only near the null line of the magnetic field. The measured energy spectrum differs from a Maxwellian spectrum in the presence of an excess of electrons at energies above 10 T/sub e/. The results confirm that fine-scale turbulence develops in the sheet.

55383 **Refraction diagnostics of a randomly inhomogeneous plasma.** Bezrodnyi, V.G.; Dushin, L.A.; Serikov, A.V. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* 22: No. 1, 31-35(Jan 1977).

The influence of stratified random inhomogeneities of a medium on the refraction of an electromagnetic wave is studied. It is shown that fluctuations of the point at which the ray emerges are governed by the fluctuations of the turning point in the medium when the gradients of the random component of the refractive index exceed the average gradient, which governs the regular refraction. The possible application of these results to the diagnostics of a randomly inhomogeneous, non-gyrotropic plasma is discussed.

55384 **Microwave diagnostics of laser-produced plasma.** Chernyshev, L.E. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* 22: No. 1, 42-46(Jan 1977).

Local measurements of the electron density distribution are carried out in an expanding laser-produced plasma. These measurements yield the spatial profiles of the electron density at various times. These profiles are governed by the time evolution of the laser pulse.

55385 **Some features of the diagnostics of a plasma placed inside the resonator of a gas laser.** Meinikov, L.A.; Tuchin, V.V. *Opt. Spectrosc. (USSR) (Engl. Transl.);* 42: No. 3, 242-246(Mar 1977).

A method of plasma spectroscopy using a gas laser is considered in which the frequency deviation of the emission is measured when the refractive index of the plasma, placed in the laser resonator, is modulated. The possibility of measuring the density of different components of the plasma (electrons and atoms in metastable states) without probing the plasma with the emission of a laser at two different wavelengths, and also the possibility of simultaneously determining the density buildup time are demonstrated. Some features of the probing of a plasma with the emission of a multimode laser are considered.

55386 **Estimate of the error of optical diagnostic methods for axially symmetric plasmas.** Grigoreva, L.Z.; Kostometov, G.P.; Leonov, S.N.; Liukonen, R.A.; Flegontov, Y.A. *Opt. Spectrosc. (USSR) (Engl. Transl.);* 42: No. 3, 247-250(Mar 1977).

For the axially symmetric channel produced by an arc discharge in a gas the relationship between the radial distribution of the absorption coefficient and the attenuation of the probing light beam is given by an integral equation of the Abel type. A computer solution n (r) of the integral equation is obtained through a piecewise-linear approximation of the experimental function u (x). A formula to estimate the error in the solution of the equation is found by means of an a priori restriction on the first derivative of n (r). Calculations of this estimate are carried out for several variance and step values. The function found for the absorption coefficient and the experimentally measured distribution of the spectral brightness of the plasma are used for a computer calculation of its radial temperature distribution.

55387 **Spatial resolution of X-ray line emission in laser produced plasma by shadow technique.** Zigler, A.; Zmora, H.; Komet, Y. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). *Phys. Lett., A;* 60: No. 4, 319-322(7 Mar 1977).

Spatial resolution of X-ray emission from laser-produced plasmas is obtained by placing a 500 μm wire between the plasma and a slitless crystal spectrometer. The sizes of emitting regions of various spectral lines, as well as electron temperature and density spatial profiles are deduced for an Al plasma.

55388 **Method for analysis of experimental data on spherical irradiation of laser target.** Magnitskii, N.A.; Magnitskii, S.A. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR,

Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 441-444(Apr 1977).

An application is considered of the authors' algorithm for the solution of the Abel equation, stable on the right-hand side, in an analysis of the experimental data obtained as a result of contactless diagnostics of spherically symmetric plasma objects. Examples are given of calculations of laser plasma parameters whose distribution functions have different degrees of smoothness. A comparison is made of the proposed method with the techniques used currently in the solution of the Abel equation.

55389 High-speed multiframe interferometry in a laser beam. Zakharenkov, Y.A.; Rode, A.V.; Sklizkov, G.V.; Fedotov, S.I.; Shikanov, A.S. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 4, 453-457(Apr 1977).

A description is given of high-speed multiframe interferometry for investigating the spatial distribution of the electron density in plasmas. Special attention is paid to a method for synchronizing a laser source of probe radiation pulses of approximately-less-than1 nsec duration with the beginning of the process being investigated. It is shown that the proposed method can be used for effective monitoring of the degree of symmetry of a laser plasma during the initial stage of expansion after spherical irradiation of a target.

55390 Plasma diagnostic using high-resolution spectroscopic techniques. Feldman, U.; Doschek, G.A. (E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, D.C. 20375). *J. Opt. Soc. Am.;* 67: No. 6, 726-734(Jun 1977).

Density-sensitive line intensity ratios measurable in high-resolution spectra are discussed for high-temperature plasmas (1.5—1300 eV). By working along isoelectronic sequences, it is possible to find density-sensitive ratios over a wide range of electron densities (10^{12} to $\sim 10^{21}$ cm^{-3}). This range includes the density of a number of laboratory plasmas of current interest. We also discuss the temperature sensitivity of some of the line ratios for ions formed in the colder plasmas with temperatures of 1.5—15 eV. We present a table of forbidden lines obtained from Skylab spectra of the solar corona. Lines of this type should be detectable in certain laboratory spectra. Their long wavelengths make these lines particularly suitable for measuring the ion temperature or nonthermal motions. Finally, we show the feasibility of detecting megagauss magnetic fields in high-temperature plasmas, from profiles of selected spectral lines.

PLASMA KINETICS - GENERAL

55391 (AD-A—038967) Expansion of an ion sheath into a collision-dominated plasma. Technical summary report. Lonngren, K.E. (Wisconsin Univ., Madison (USA). Mathematics Research Center). Mar 1977. Contract DAAG29-75-C-0224. 11p. (MRC-TSR—1737). NTIS PCA02/MF A01.

If a large negative voltage is applied to an insulated disc inserted in a collision-dominated plasma, the electrons are expelled from the region near the disc leaving a bare cloud of ions. This transient sheath is well documented in ion acoustic wave experiments. This paper examines the evolution of the ions in this sheath into a collision-dominated plasma. A new sheath whose dimension is of the order of twice the transient sheath dimension is found. (Author)

55392 (N—77—17853) Electron dynamics in a plasma focus. Hohl, F.; Gary, S.P.; Winters, P.A. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Feb 1977. 37p. (NASA-TN-D—8356; L—11125). NTIS, PC A03/MF A01.

Results are presented of a numerical integration of the three-dimensional relativistic equations of motion of electrons subject to given electric and magnetic fields deduced from experiments. Fields due to two different models are investigated. For the first model, the fields are those due to a circular distribution of axial current filaments. As the current filaments collapse toward the axis, large azimuthal magnetic and axial electric fields are induced. These fields effectively heat the electrons to a temperature of approximately 8 keV and accelerate electrons within the radius of the filaments to high axial velocities. Similar results are obtained for the current-reduction phase of focus formation. For the second model, the fields are those due to a uniform current distribution. Both the current-reduction and the compression phases were studied. These is little heating or acceleration of electrons during the compression phase because the electrons are tied to the magnetic field. However, during the current-reduction phase, electrons near the axis are accelerated toward the center electrode and reach energies of 100 keV. A criterion is obtained which limits the runaway electron current to about 400 A.

55393 (UCRL—79377) Electron energy and space charge calculations in reflex diodes. Shearer, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 May 1977. Contract W-7405-ENG-48. 13p. (CONF-770548—1). Dep. NTIS, PC A02/MF A01.

From Annual conference on controlled fusion theory; San Diego, California, United States of America (USA) (4 May 1977).

Previously reported Monte Carlo code calculations of the electron energy distributions and the consequent reflex triode characteristics will be presented for two different anode designs. In addition, a generalized formulation of Poisson's equation will be used to examine the virtual cathode side of a reflex diode. The familiar "resonance" solution for the reflex triode is again found, but with a different physical interpretation. In the former case the current diverges, but in the virtual cathode space the linear dimension diverges as one approaches the "resonance."

55394 Plasma Phenomena in gas discharges. Franklin, R.N. Oxford; Oxford University Press (1976). 257p.

The effects of collisions, space charge, and charged particle generation on both steady-state and time-varying plasmas are considered and wave propagation including such effects is described. The types of wave treated include electron plasma, ion acoustic, ionization, electron and ion cyclotron, Alfven, whistler, and drift waves. (MOW)

55395 Head-on collisions between radiation-driven fronts with self-consistent absorption. Yangos, J.P.; Halverson, W. (Massachusetts Inst. of Tech., Cambridge (USA). National Magnet Lab.). *Phys. Lett., A;* 60: No. 1, 37-38(24 Jan 1977).

Head-on collisions between supersonic radiation fronts have been analyzed using a self-consistent calculation of the absorption of driving radiation in the collision zone. Somewhat lower temperatures are found for collisions between weakly compressed radiation fronts than when all of the incident radiation is absorbed.

PLASMA KINETICS - EXPERIMENTAL

55396 (JAERI-M—6720) Experimental evaluation of electron heat conductivity in high-temperature Tokamak plasmas. Matoba, T.; Funahashi, A. (Japan Atomic Energy Research Inst., Tokyo). Sep 1976. 22p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

The electron heat conductivities in JFT-2 and JFT-2a plasmas have been determined experimentally from the electron energy transport equation using the electron temperature and density distributions measured by Thomson scattering and microwave interferometry. In the analysis, the ion temperature is considered but the particle diffusion and the recombination and excitation radiation losses emitted from impurities are neglected. The effective ionic charge, which has large influence on the energy balance of the plasma, is determined from the plasma conductivity, plasma current and loop voltage. The electron heat conductivity in the central plasma column can be evaluated reasonably assuming that the particle diffusion and the radiation losses are negligible. In the outer plasma region however, the radiation losses are dominant, so reliable estimation is impossible. The electron heat conductivities in the central region of JFT-2 and JFT-2a plasmas exceed the neoclassical values by a great deal and nearly equal to the pseudo-classical or Bohm ones.

55397 (ORNL—5275, pp 19-100) Tokamak experimental section. Berry, L.A.; Dunlap, J.L.; Arakawa, E.T. Jun 1977.

In Fusion Energy Division annual progress report for period ending December 31, 1976.

Descriptions of research during this period are given for the following topics: (1) ion and electron heating, (2) high-beta and gas puff experiments, (3) beam trapping by impurities, (4) counterinjection studies, (5) impurity measurements, (6) Balmer alpha line profiles, (7) internal mode structure, (8) sawtooth oscillations and plasma transport, (9) Ormak plasma modeling, (10) charge exchange measurements, (11) wall power measurements, (12) neutron time behavior due to deuterium neutral beam injection into a hydrogen plasma, (13) wall impurities in Ormak, (14) relativistic electron studies, (15) fast x-ray energy analyzer for the 1 to 10 keV range, and (16) CTR related atomic physics. (MOW)

55398 Observations of synchrotron radiation from the University of Maryland magnetic mirror experiment and from the ATC Tokamak. Stauffer, F.J. College Park, MD; Univ. of Maryland (1976). 187p. University Microfilms Order No. 77-13,032.

Thesis (Ph. D.).

Observations of the synchrotron radiation emitted by the mildly relativistic electron cloud trapped in the University of Maryland magnetic mirror compression device were made with two fixed frequency microwave superheterodyne receivers (9.3 GHz and 35 GHz) and a 5-channel far infrared polychromator that was sensitive over the wavelength range 0.1 to 8 mm (38-3000 GHz). An algorithm was developed to unfold the total energy distribution of the trapped electron cloud from the microwave measurements by means of a digital computer. Microwave measurements of the synchrotron radiation were made for 3 different injection voltages. Application of

the unfolding algorithm to these measurements indicated that: (1) the number of trapped electrons was of the order 10^{10}. (2) The evolution of the energy distribution function during the decay of the magnetic field was approximately consistent with the assumption that the first adiabatic invariant is conserved for each electron. (3) The electron energies corresponded to injection voltages that were less than, or equal to, the gun voltage that was used. A similar energy distribution was used to compute the expected far infrared synchrotron spectrum, which agreed to within a factor of 4 with the experimental far infrared spectrum.

55399 Spectroscopic studies of adiabatic compression in a tokamak. Kaganskii, M.G.; Kalmykov, S.G.; Lebedev, S.V.; Shakhovets, K.G. (AN SSSR, Leningrad. Fiziko-Tekhnicheskij Inst.). pp 387-396 of In Plasma physics and controlled nuclear fusion research 1976. Vol. I. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The line radiation of impurity ions in the visible and ultraviolet regions was measured during adiabatic compression of a plasma in the Tuman-2 tokamak. This enabled the radial distribution of the electron temperature to be determined. The marked asymmetry of this distribution along the major radius in the compressed plasma column is due to outward displacement of the magnetic surfaces as a result of the increase in βsub(I) during compression. Calculations show that during compression βsub(I) increases from 0.6 to 2-2.5. The maximum electron temperature in the compressed plasma, approximately 400 eV, is 1.7 times higher than that calculated on the assumption of purely adiabatic heating. This indicates that the heat insulation of the plasma is improved. The energy life-time increases from 150 μs during Ohmic heating to 800μs in the compressed plasma. Spectroscopic measurements also show that the flux of lightweight impurities penetrating the plasma is halved during compression.

PLASMA KINETICS - THEORETICAL

REFER ALSO TO CITATION(S) 54450, 55542

55400 (IPP—6/147, pp v) **In search of stable 3 D MHD-equilibria.** Chodura, R.; Schlueter, A. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

2 figs.

In Computing in plasma physics and astrophysics. Proceedings. Session C: MHD-equilibrium and stability. C 2.

A possible way of finding 3 D MHD-equilibria is to time-integrate a modified system of MHD equations where inertia has been replaced by a fictitions friction (MHF-model). Starting from a variational formulation the discretisation of the equations is described. By several methods the admissible time-step of the explicit integration is improved by a factor of about 10^3 over the usual stability condition. The method is used to look for the final state of unstable screw-pinch and tokamak type equilibria.

55401 (IPP—6/147, pp v) **Axisymmetric stability of numerically computed Tokamak equilibria.** Lackner, K. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

1 fig.; 8 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session C: MHD-equilibrium and stability. C 4.

A computer code is developed testing arbitrary, numerically computed equilibria against general axisymmetric modes.

55402 (IPP—6/147, pp v) **General approach to solving the rate equations for ionisation-recombination processes in a plasma.** Magill, J.; Laing, E.W.; Tahir, N. (Glasgow Univ. (UK). Dept. of Natural Philosophy). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

4 figs.; 3 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session G: Transport in laboratory plasmas. G 5.

The aim of the present work is to develop computer models for the atomic physics processes in a partially ionised time evolving plasma. Such models must be efficient and accurate as they are intended to supplement an MHD description of the plasma in computer codes. Instead of solving for the ionisation fractions directly, the method used here solves for the moments of the distribution function of the ionisation stages.

55403 (JAERI-M—6727) **Behavior of plasma ions near the separatrix in a tokamak with a poloidal divertor.** Saito, R.; Seki, S.; Kitsunezaki, A.; Matsuda, T.; Yokomizo, H. (Japan Atomic Energy Research Inst., Tokyo). Oct 1976. 31p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Velocity space behavior of plasma ions near the separatrix is important in plasma transport phenomena. Loss regions in velocity space, including the loss of plasma ions into the divertor plates, are discussed in detail by analytic and numerical methods. The width of plasma scrape-off is of the order of the ion poloidal gyroradius.

55404 (ORNL—5275, pp 101-166) **Plasma Theory Division.** Callen, J.D.; Dory, R.A.; Aghevli, R. Jun 1977.

In Fusion Energy Division annual progress report for period ending December 31, 1976.

The progress during the past year is organized by group efforts and divided into five major areas. The basic tokamak areas and the sections in which their work is summarized are: magnetohydrodynamic (MHD) theory, kinetic theory, and transport simulation. The ELMO Bumpy Torus (EBT) theory work has its own research projects on MHD theory, kinetic theory, and transport simulation. In the plasma engineering area, relevant research work is further developed and synthesized into models that are used in the design of advanced fusion systems—The Next Step (TNS), demonstration fusion reactor (Demo), EBT ignition test, etc. Specific plasma engineering projects on providing the TNS physics basis and the development of the EBT reactor study are discussed. The computing support activities during the past year are summarized.

55405 Transport properties of a tokamak plasma with impurities. Moore, T.B. Austin, TX; Univ. of Texas (1976). 114p. University Microfilms Order No. 77-11,557.

Thesis (Ph. D.).

Transport properties of an impure Tokamak plasma have been investigated for arbitrary charge and mass ratios of the ion species. Using the Fokker-Planck collision term for both like-ion and unlike-ion collisions, the classical transport problem with electric field and pressure and temperature gradient driving forces is solved. Using variational methods, the classical transport coefficients and the ion and impurity distribution functions are determined. These results are used to calculate, again by variational means, neoclassical transport coefficients for the banana-plateau regime. As in the case of a simple plasma, the transport coefficients, which exhibit a gradual transition from banana regime to plateau regime, are fitted to simple functions of the ion and impurity collisionality parameters. Using a moment equation approach, previous results in the Pfirsch-Schluter regime are generalized to arbitrary charge and mass ratios. A simple and efficient FORTRAN subroutine which evaluates the Pfirsch-Schluter transport coefficients is presented. The moment equations for a plasma with one impurity specie are discussed in detail.

55406 Equilibrium and stability properties of relativistic electron rings and E-layers. Uhm, H. College Park, MD; Univ. of Maryland (1976). 151p. University Microfilms Order No. 77-13,037.

Thesis (Ph. D.).

Equilibrium and stability properties of magnetically confined partially-neutralized thin electron ring and E-layer are investigated using the Vlasov-Maxwell equations. The analysis is carried out within the context of the assumption that the minor dimensions (a,b) of the system are much less than the collisionless skin depth (c/antiω/sub p/). The equilibrium configuration of the E-layer is assumed to be an infinitely long, azimuthally symmetric hollow electron beam which is aligned parallel to a uniform axial magnetic field. On the other hand, the electron ring is located at the midplane of an externally imposed mirror field which acts to confine the ring both axially and radially. The equilibrium properties of the E-layer and electron ring are obtained self-consistently for several choices of equilibrium electron distribution function. The negative-mass instability analysis is carried out for the relativistic E-layer equilibrium in which all of the electrons have the same transverse energy and a spread in canonical angular momentum, assuming a fixed ion background. The ion resonance instability properties are investigated for a relativistic nonneutral E-layer aligned parallel to a uniform magnetic field and located between two ground coaxial cylindrical conductors. The stability properties of a nonrelativistic electron ring is investigated within the framework of the linearized Vlasov-Poisson equations. The dispersion relation is obtained for the self-consistent electron distribution function in which all electrons have the same value of energy an the same value of canonical angular momentum. The positive ions in the electron ring are assumed to form an immobile partially neutralizing background. The stability criteria as well as the instability growth rates are derived and discussed including the effect of geometrical configuration of the system. Equilibrium space-charge effects play a significant role in stability behavior.

55407 Computation of ideal MHD equilibria. Lackner, K. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). *Comput. Phys. Commun.*; 12: No. 1, 33-44(Sep 1976).

From 2. European conference on computational physics; Garching/Muenchen, Germany, F.R. (27 - 30 Apr 1976).

This paper reviews two- and three-dimensional ideal MHD equilibrium codes, with particular emphasis on axisymmetric toroidal calculations. In this case (Tokamak geometry), the equilibrium problem can be formulated in three essentially different ways, depending on whether (I) mirror currents in a copper shell or (II) given, applied external currents provide for balancing of the hoop force and shaping of the plasma column, or (III) one looks for distributions of applied currents producing a prescribed plasma surface. Numerical problems arising from these formulations discussed in detail concern (1) suitable iteration procedures to treat the non-linearity of the problem, (2) fast solution methods for the linearized equations in bounded and unbounded domains and (3) the fact the formulation III constitutes a badly posed problem in the sense of Hadamard.

55408 Computation of Tokamak transport. Mercier, C.; Boujot, J.P.; Werkoff, F. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). *Comput. Phys. Commun.;* **12**: No. 1, 109-119(Sep 1976).

From 2. European conference on computational physics; Garching/Muenchen, Germany, F.R. (27 - 30 Apr 1976).

The complexity of the equations describing the transport phenomena in Tokamaks requires the use of numerical codes for simulation. These codes assume that the plasma is a multifluid medium. They involve equations for the evolution of electrons, light ions and current density, equations for heavy ions (impurities) and elaborate models for the evolution of the neutrals of light atoms. These codes allow testing of the existing theories and deduction of empirical rules and coefficients. After the Fontenay-aux-Roses code has been presented in more detail, examples of a few applications of this code are given.

55409 Relaxation of toroidal discharges. Jukes, J.D. (UKAEA Research Group, Abingdon. Culham Lab.). pp 479-488 of In Plasma physics and controlled nuclear fusion research 1976. Vol. I. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

A generalized energy principle is derived, based on the invariance of a volume integral K, rather than perfect plasma conductivity, and to include finite plasma pressure. It is found that the permissible ('special') equilibria are a subset of those allowed in ideal MHD. Moreover, finite pressure severely restricts the possibility of symmetric configurations. Thus axisymmetric, toroidal discharges, such as tokamaks and pinches with weak but finite pressure, are shown not to exist within the special equilibria. An integral function is derived to permit the further study, by variational methods, of the stability of the special equilibria to perturbations which are K-invariant. A physical mechanism is proposed in outline for self-generated field reversal in pinches. Initially, a kink instability of a strongly pinched column generates a helical deformation. Tearing of the flux surfaces due to plasma resistivity permits independent flux tubes to arise, each with its own enclosed magnetic axis and longitudinal current I. A transverse elongation of a flux tube can occur, driven by the release of MHD energy. This amplifies I which is aligned approximately along the helix, corresponding to the original undeformed field lines. The magnetic field induced by I tends to reverse the direction of the axial field in the outer regions beyond the helix, although non-uniformly. Finally, the flux surfaces rejoin into a more symmetric configuration of lower energy by a process which appears as a time-reversed tearing mode of instability accompanied by a reduction in the number of magnetic axes.

55410 Symmetry group of the kinetic equation and stationary distributions in a weakly turbulent plasma. Kats, A.V.; Kontorovich, V.M. (Khar'kovskij Gosudarstvennyj Nauchno-Issledovatel'skij Inst. Metrologii (Ukrainian SSR)). *Physica, A;* **86**: No. 2, 471-474(1977).

A class of essentially non-equilibrium distributions characterized by the constant flux of one of the 'integrals of motion' (e.g. energy, number of particles or momentum) both for waves and particles is shown to exist in plasmas due to the symmetry of collision integrals (particle-wave interactions or Boltzmann's integral resp.). As a result, the non-equilibrium distributions can be obtained from a functional equation inferring that the projection of the stoss-integrand on the irreducible group representation should be equal to zero.

55411 Rate of energy loss by a charged particle moving in a plasma cylinder. Swami, K.C.; Sharma, S.R. (Rajasthan Univ., Jaipur (India). Dept. of Physics). *Physica, B, C;* **85**: No. 1, 201-208(1977).

The rate of energy loss by a charged particle moving with a relativistic velocity along the axis of a dielectric cylinder of infinite length surrounded by a medium of another dielectric constant has been calculated. The case of a cold plasma cylinder has been considered in detail in which the dielectric constant of the outer medium is taken to be infinite or unity.

55412 Electrical conductivity tensor of a Coulomb plasma. Baird, A.M. Hanover, NH; Dartmouth Coll. (1977). 128p. University Microfilms Order No. 77-12,522.

Thesis (Ph. D.).

The frequency dependent electrical conductivity tensor of a fully ionized, two component plasma is calculated to first order in the plasma parameter, including the leading order finite wavelength corrections. The calculation is based upon the rigorously derived BBGKY hierarchy of equations, truncated to first order in the plasma parameter and linearized about a spatially homogeneous Maxwellian equilibrium. A kinetic equation is formed, assuming a stable plasma, by solving the second equation of the hierarchy for the perturbed pair correlation function is terms of the perturbed distribution function. This solution is accomplished for arbitrary frequencies and wavevectors by two separate techniques, the Guernsey integral equation method and the Dupree operator method, and the equivalence of the two results is demonstrated.

55413 Equilibrium and stability of the l = 2 stellarator without longitudinal current. Lortz, D.; Nuehrenberg, J. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). *Nucl. Fusion;* **17**: No. 1, 125-133(1977).

The expansion of the l = 2 stellarator magnetohydrostatic equilibrium around its circular magnetic axis is reconsidered. All parameters occurring up to third order in the distance from the magnetic axis are kept finite. Equilibrium and stability plasma β estimates are calculated in connection with a discussion of stagnation points occurring in the third-order flux surfaces. Results for the case without toroidal current are: irrespective of the five parameters describing this type of stellarator, there are universal bounds for the β estimates of 0.66% and 0.22% for the necessary and the sufficient stability criterion, respectively.

55414 Long-time behavior of the nonlocal shear viscosity of a one-component plasma: a microscopic approach. Baus, M. (Univ. Libre, Brussels); Wallenborn, J. *J. Stat. Phys.;* **16**: No. 1, 91-111(Jan 1977).

The nonlocal shear viscosity eta(t) of a classical one-component plasma is shown to have an oscillatory long-time tail. This result is obtained on the basis of a microscopic theory which does not rely on expansions in a small parameter such as the plasma expansion parameter. Our major approximation is the restriction to the coupling of two hydrodynamic propagators in the computation of the long-time behavior of the transport matrix. The Coulomb divergence is correctly accounted for, while the nonanalyticities of both the plasma parameter and gradient expansions are discussed at the level of the kinetic as well as the hydrodynamic equations.

55415 Conductivity sum rules for the relativistic two component plasma. Golden, K.I. (Ecole Polytechnique Federale, Lausanne (Switzerland)). *Phys. Lett., A;* **59**: No. 6, 451-454(10 Jan 1977).

Using the Kubo sum rule theorem, external conductivity frequency moment sum rules are derived for the relativistic two-component plasma in a constant external magnetic field.

55416 Lorentz covariant eikonal method in magnetohydrodynamics. I. The dispersion relation. Heintzmann, H. (Koeln Univ. (Germany, F.R.). Inst. fuer Theoretische Physik); Schrueffer, E. (Bonn Univ. (Germany, F.R.)). *Phys. Lett., A;* **60**: No. 1, 79-80(24 Jan 1977).

A manifestly Lorentz covariant method is developed to describe wave propagation through a cold one-component plasma in arbitrary motion. The covariant eikonal method is applied to a model pulsar plasma and the dispersion relation is derived.

55417 Perturbation theory for the Korteweg-de Vries equation. Karpman, V.I.; Maslov, E.M. (Izmiran, Academic City, Moscow Region, USSR). *Phys. Lett., A;* **60**: No. 4, 307-308(7 Mar 1977).

By writing the perturbed Korteweg-de Vries equation in operator form, equations are derived which are a basis for a perturbation method. In particular, in the first approximation, the authors obtain from them equations describing the evolution of the soliton amplitude and velocity. The present theory may be extended, also, to other nonlinear evolution equations if they are solved, without perturbation, by the inverse-problem method.

PLASMA PRODUCTION

55418 (N—77—17851) Analysis of plasmas generated by fission fragments. Deese, J.E.; Hassan, H.A. (North Carolina State Univ., Raleigh (USA)). Jan 1977. 52p. (NASA-CR—2776). NTIS, PC A04/MF A01.

A kinetic model is developed for a plasma generated by fission fragments and the results are employed to study helium plasma generated in a tube coated with fissionable material. Because both the heavy particles and electrons play important roles in creating the plasma, their effects are considered simultaneously. The calculations are carried out for a range of neutron fluxes and pressures. In general, the predictions of the theory are in good

agreement with available intensity measurements. Moreover, the theory predicts the experimentally measured inversions. However, the calculated gain coefficients are such that lasing is not expected to take place in a helium plasma generated by fission fragments. The effects of an externally applied electric field are also considered.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 55486

55419 (IPP—6/147, pp v) **Finite element approach to the quasi-linear evolution of the gentle bump instability in a 2-D plasma.** Appert, K.; Tran, T.M.; Vaclavik, J. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherches en Physique des Plasmas). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

4 figs.; 7 refs.

In Computing in plasma physics and astrophysics. Proceedings. Poster session. P 3.

Although the basic equation of the quasi-linear theory of plasma turbulence were formulated more than one and half decade ago, it is not yet much known about their solutions for non-one-dimensional systems. By analytical means, only certain general features of possible asymptotic states of the system can be deduced. The relaxation dynamics as well as the final state of the system remain unknown. In the present work an attempt is made to attack these problems by a numerical procedure. In particular, the evolution of the gentle bump instability in a nonmagnetized 2-D plasma is investigated within the framework of the quasi-linear equations by means of the finite element method.

55420 (IPP—6/147, pp v) **Two-dimensional MHD stability code with a finite hybrid expansion in both directions.** Berger, D.; Gruber, R.; Troyon, F. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherches en Physique des Plasmas). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

5 figs.; 6 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session C: MHD-equilibrium and stability. C 3.

A new MHD stability code which computes the spectrum and the corresponding eigenvectors of a general toroidal axisymmetric equilibrium is described. It is based on a 'finite hybrid elements' expansion. Test runs show very good convergence properties even for the slow growing localized modes.

55421 (IPP—6/147, pp v) **Numerical studies of resistive instabilities.** Biskamp, D.; Welter, H. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

6 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session D: Nonlinear MHD behavior of plasmas. D 2.

A special magnetohydrodynamic model is used to describe numerical investigations of the linear and nonlinear evolution of various kinds of resistive instabilities.

55422 (IPP—6/147, pp v) **Turbulent transport in reversed field pinches.** Christiansen, J.P.; Roberts, K.V. (UKAEA Research Group, Abingdon. Culham Lab.). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

11 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session G: Transport in laboratory plasmas. G 3.

MHD stability of the Reversed Field Pinch (RFP) relies on reversal of the toroidal field component in the outer plasma region. Interest in this configuration comes from its potential economic advantages as a thermonuclear reactor, since compared to a Tokamak the RFP supports a higher value of β, the ratio between plasma and total magnetic pressure. Results of computations on the time-evolution of the RFP using a 1D MHD model are reported.

55423 (IPP—6/147, pp v) **MHD instabilities of 2D diffuse high-beta equilibria as an initial-boundary-value problem.** Herrnegger, F.; Schneider, W. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

4 figs.; 11 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session C: MHD-equilibrium and stability. C 5.

A time-dependent explicit finite difference code is used for computing very small growth rates of gross MHD modes in helically symmetric equilibria. The problem of numerical dispersion and the convergence for fine grids is discussed. For equilibria with long helical period length, the eigenvalues computed by this code are in agreement with those of a deltaW analysis and the experiment, and are by a factor of two smaller than surface current theory predicts.

55424 (IPP—6/147, pp v) **Theory and simulation on the anomalous transport due to drift wave instabilities.** Kuo, Y.Y.; Lee, W.W.; Okuda, H.; True, M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

3 figs.; 3 refs.

In Computing in plasma physics and astrophysics. Prodeedings. Session B: Particle simulation in plasmas and stellar systems. B 2.

A 2-1/2 dimensional electrostatic particle simulation code capable of handling a nonuniform and bounded system was used. It is reported a) on results for the nonlinear evaluation of the stability and the accompanied particle and energy transport along the scaling laws in the presence of shear and b) on theoretical investigations on the universal mode using a self-consistent quasilinear approach based on the observation of the simulation results.

55425 (IPP—6/147, pp v) **Numerical simulation of dissipative trapped-electron instability.** Matsuda, Y.; Okuda, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

3 figs.; 4 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session B: Particle simulation in plasmas and stellar systems. B 3.

A 2 1/2 dimensional simulation model has been developed to study the trapped electron instability in a linear geometry.

55426 (IPP—6/147, pp v) **Analytical and numerical study of MHD instabilities in rotating plasmas.** Spies, G.O. (New York Univ., N.Y. (USA). Courant Inst. of Mathematical Sciences). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

In Computing in plasma physics and astrophysics. Proceedings. Session C: MHD-equilibrium and stability. C 6.

Since plasma rotation is observed in confinement experiments, the normal modes in rotating straight theta pinches of infinite length are investigated. It is the objective to obtain a qualitative picture of the structure of the spectrum in the complex plane, and to determine the growth rates of gross instabilities quantitatively.

55427 (JAERI-M—6693) **Shell effects of vacuum vessel for the positional instability.** Yokomizo, H.; Seki, S.; Kitsunezaki, A.; Matsuda, T.; Saito, R. (Japan Atomic Energy Research Inst., Tokyo). Sep 1976. 37p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Shell effects are important to stabilize the positional instability of a tokamak plasma with a non-circular cross section. Numerical calculations of the shell effects of the vacuum vessels with circular and rectangular cross sections are presented. The numerical method is assessed by comparing the calculated results of the vacuum vessels with a circular cross section with the analytical ones.

55428 **Nonlinear stabilization of modulation instability.** Khakimov, F.Kh.; Tsytovich, V.N. (Tadzhikskij Gosudarstvennyj Univ., Dushanbe (USSR)). *Zh. Eksp. Teor. Fiz.;* 70: No. 5, 1785-1794(May 1976). (In Russian).

The process of nonlinear stabilization of modulation instability is considered. More exact dynamic equations are obtained which take into account higher order electron nonlinearities. On the basis of these equations nonlinear restrictions on the development of modulation perturbations are found which indicate that the Langmuir collapse is forbidden. A possibility for fast Langmuir solitons is shown to exist.

55429 **Recent developments in the computational aspects of MHD stability.** Grimm, R.C.; Johnson, J.L. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). *Comput. Phys. Commun.;* 12: No. 1, 45-52(Sep 1976).

From 2. European conference on computational physics; Garching/Muenchen, Germany, F.R. (27 - 30 Apr 1976).

In recent years variational methods have been applied successfully to the numerical determination of the spectra for simple linearized ideal magnetohydrodynamic models. Currently, several extensive efforts have been undertaken to implement these approaches to determine the normal modes for general axisymmetric

toroidal equilibria, especially those applicable to the Tokamak experimental program. This paper reviews the motivation, the difficulties, and the various numerical approaches employed. Several simple illustrative results are given.

55430 Non-linear behaviour of hydromagnetic instabilities. Wesson, J.A. (UKAEA Research Group, Abingdon. Culham Lab.). *Comput. Phys. Commun.;* **12**: No. 1, 53-65(Sep 1976).

From 2. European conference on computational physics; Garching/Muenchen, Germany, F.R. (27 - 30 Apr 1976).

There has recently been a growth of interest in the non-linear development of hydromagnetic instabilities. The theoretical attack on this problem has been largely numerical and has been carried out by obtaining the time dependent solution to the set of hydromagnetic equations appropriate to each problem. The earliest calculations used the ideal hydromagnetic equations but many of the more realistic problems require the introduction of resistive effects to allow for changes in magnetic topology and for ohmic heating. This paper gives a description of some of the recent calculations, relevant to magnetic confinement systems, concentrating particularly on Tokamak and pinch configurations.

55431 Observation of disruptive-instability fine structure in a tokamak. Mirnov, S.V.; Semenov, I.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 291-299 of In Plasma physics and controlled nuclear fusion research 1976. Vol. I. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The T-4 device was used to study the correlation between the external manifestations of the disruptive instability of magnetic fields, and the fluctuations of X-radiation from central regions of the plasma column. The development of the disruption showed a complex time sequence. The m=2 helical perturbation (pre-disruption) plays an initiating role with respect to the disruption. It is probable that "mixing", i.e. equalization of electron temperature and current gradients, takes place as a result of the development of the m=1 instability at the column centre. A column with a flattened current density distribution, j(r), is unstable relative to helical m=2,3,4 MHD perturbations. Their non-linear development signifies the final stage of disruption. This chain of events makes it possible to correlate all the basic experimental facts pertaining to the development of this instability. A possible electrodynamic scheme of generation of negative voltage in the disruption is proposed.

55432 Non-linear tearing modes in tokamaks. White, R.B.; Monticello, D.A. (Princeton Univ., N.J. (USA). Plasma Physics Lab.); Rosenbluth, M.N.; Waddell, B.V. (Institute for Advanced Study, Princeton, N.J. (USA)). pp 569-577 of In Plasma physics and controlled nuclear fusion research 1976. Vol. I. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

Numerical codes have been developed for the description of the non-linear evolution of tearing modes in tokamaks. The m=1 mode is observed to continue rapid growth in the non-linear regime, producing significant changes on a time scale consistent with the experimentally observed minor disruption. The double tearing mode associated with a hollow current profile also continues rapid growth in the non-linear regime, and thus may play a significant role in the anomalous current penetration during the early stages of a tokamak discharge. Single magnetic islands with m<=2, on the other hand, cease exponential growth upon entering the non-linear regime and saturate shortly thereafter. A model for the saturation processes is presented. Modifications due to thermal transport are discussed.

55433 Finite-Larmor-radius stabilization of the m = 2 instability in the ISAR T1-B high-beta stellarator. Neuhauser, J.; Kaufmann, M.; Roehr, H.; Schramm, G. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). *Nucl. Fusion;* **17**: No. 1, 3-11(1977).

The m = 2 mode stability is investigated in the ISAR Tl-B toroidal high-beta stellarator (major diameter 2.7 m, capacitor bank energy 0.5 or 1.5 MJ) for a great variety of plasma parameters using deuterium filling gas (0.5 < omega/sub L/ x tau/sub ii/ < 200; 0.1 < r/sub L//a < 0.35; omega/sub L/ = ion Larmor frequency; r/sub L/ = ion Larmor radius; a = plasma radius; tau/sub ii/ = ion self-collision time). The ion mass dependence was checked by a small number of discharges with hydrogen. For r/sub L//a < eta/sub crit/, eta/sub crit/ = 0.14, fast-growing m = 2 modes were found, the limit eta/sub crit/ being essentially independent of the collision frequency within the accessible range (2 < omega/sub L/ x tau/sub ii/ < 20). For r/sub L//a < 0.14 no fast-growing m = 2 modes were observed, the plasma lifetime being limited by a m = 1, k approximately 0 mode. The normalized growth rate, anti γ = γ/(V/sub i//a) = 0.15 +- 0.05, (V/sub i/ = ion thermal speed) was about half the sharp boundary value and slightly higher than that calculated for a diffuse pressure profile. The experimentally determined minimum value of r/sub L//a, for which the m = 2 mode is stabilized, is by about a factor of three smaller than Freidberg's estimation using a sharp-boundary Vlasov model. Advanced calculations in a sharp boundary model by Lewis and Turner deviate in the critical limit only by a factor of about 1.5 and recent results using a diffuse pressure profile by Herrnegger and Schneider and by Freidberg and Hewett agree quite well with the experimental data.

55434 Radiation pressure at the surface of a beam of coherently radiating electrons. Krasovitskii, V.B. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 1, 4-10(Jan 1977).

The radiative-damping force acting on the surface of a rectilinear beam of relativistic electrons is derived for the case in which the electrons move in a plasma and the two-stream instability is excited. The physical mechanism for this effect is discussed in detail. The possibility of exploiting this effect for radial focusing of a beam by means of radiation is discussed.

55435 Nonlinear saturation of the Buneman instability. Ionson, J.A. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). *Phys. Lett., A;* **60**: No. 1, 27-28(24 Jan 1977).

Buneman turbulence may be treated as normal-mode plasma fluctuations supported by quasi-particles of effective mass m=msub(i)(msub(e)/msub(i))sup(1/3). Assuming saturation via the trapping of these quasi-particles leads to a turbulent level and associated resistivity which is in excellent agreement with the empirical results.

55436 Theory for space-time evolution of explosive-type instability. Wilhelmsson, H. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Watanabe, M.; Nishikawa, K. (Hiroshima Univ. (Japan). Faculty of Science). *Phys. Lett., A;* **60**: No. 4, 311-313(7 Mar 1977).

A solution describing space-time evolution of a resonantly interacting system of a damped negative energy wave and two undamped wave packets of positive energies is presented. It is shown that all three waves grow simultaneously when they are approaching each other, while a certain threshold condition is required for instability when they are separating.

55437 Numerical model for resistive magnetohydrodynamic instabilities. Dibiase, J.A.; Killeen, J. (Lawrence Livermore Laboratory, Livermore, California 94550). *J. Comput. Phys.;* **24**: No. 2, 158-185(Jun 1977).

A hydromagnetic model has been developed to study resistive instabilities in cylindrical geometry, and the model is applied to study specific diffuse pinch configurations. The MHD equations include the effects of compressibility, finite resistivity, viscosity, and thermal conductivity. The plasma equilibrium configuration is assumed known and is specified by B/sub theta/$_0$(r), B/sub z/$_0$(r), eta$_0$(r), /sub rho/$_0$(r), T_0(r) and these functions can be chosen to describe a particular experiment. Perturbations of the form f_1(r,t) exp[i (m/sup theta/ + k/sub z/z)] are used for all plasma and field variables, and the resulting linear partial differential equations are solved numerically as an initial value problem using an implicit difference scheme. A set of seven equations for B/sub r/$_1$, B/sub theta/$_1$, T_1, ν/sub r/$_1$, ν/sub theta/$_1$, ν/sub z/$_1$, /sub rho/$_1$ is obtained and the calculation is started by specifying an initial perturbation. For a particular problem, the parameters, m, k/sub z/, and S=tau/sub R//tau/sub H/, the ratio of resistive diffusion time to hydromagnetic transit time must be given, and for certain choices an exponential growth occurs and the growth rate p (m,k/sub z/,S) is calculated.

PLASMA WAVE PHENOMENA

55438 (IPP—6/147, pp v) Collisional damping of Bernstein echoes. Fijalkow, E.; Burgan, J.R.; Feix, M.R. (Orleans Univ., 45 (France); Centre National de la Recherche Scientifique, 45 - Orleans-la-Source (France)). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

2 figs.; 7 refs.

In Computing in plasma physics and astrophysics. Proceedings. Poster session. P 9.

The temporal evolution of Bernstein linear wave echoes and Bernstein poles are studied using a Fokker—Planck collisional model.

55439 (IPP—6/147, pp v) Magnetostatic particle code and its application to studies of anomalous current penetration of a plasma. Lin, A.T.; Pritchett, P.L.; Dawson, J.M. (California Univ., Los Angeles (USA). Dept. of Physics). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

2 figs.

In Computing in plasma physics and astrosphysics. Proceedings. Session B: Particle simulation in plasmas and stellar systems. B 1.

A large number of important plasma problems involves self-consistent magnetic fields. For disturbances which propagate slowly compared to the velocity of light, the magnetostatic approximation (Darwin model) suffices. Based on the Darwin model a particle model has been developed to investigate such problems.

55440 (KFTI—76-24) Study on spatial distribution of plasma oscillation intensity in the induced electrodeless discharge. Adamov, I.Yu.; Berezhnyi, V.L.; Kononenko, V.I. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1976. 16p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

13 refs.; 7 figs.

Space distribution of plasma oscillation intensity is studied with wavequide probes in the induced discharge plasma at Langmuir frequency. Space distribution of the intensity of the wavequide probe signal is shown to be close to real distribution of the plasma oscillation intensity. Spatial position of the resonance plasma layer with developed plasma oscillations for the same time is determined by density radial distribution along the plasma and depends upon the initial conditions of the discharge. The possible mechanism of transforming plasma oscillations into electromagnetic radiation is discussed.

55441 Experimental study of turbulent electron beam—plasma interaction with an auxiliary probing E-beam and a high frequency correlation technique. Kuyel, B. Cleveland; Case Western Reserve Univ. (1976). 200p. University Microfilms Order No. 77-11,991. Thesis (Ph. D.).

The linear, nonlinear, and turbulent regimes of the interaction of an electron beam with a collisionless plasma in a high magnetic field is experimentally studied by means of high frequency correlation techniques and an auxiliary probing electron beam. Theoretical predictions on wave growth, saturation, and the time required for the onset of a quasi-stationary state are verified. In addition, the theoretically predicted occurrence of a phase mixing regime is observed and found to be the most important effect in randomization of the initially narrow spectra of the wave electric fields. The velocity space diffusion constant D(v) is measured by a monoenergetic electron probe and the result is compared with weak and strong turbulence theories. Furthermore, anomalous damping of externally excited Langmuir waves with phase velocities much larger than the plasma electron thermal velocity (v/sub p/ greater than or equal to 4v/sub T/) is observed. An analytical model is developed which interprets this phenomena as a phase mixing decay (transient decay) due to those electrons which are trapped in the excited wave packet.

55442 Study on the cyclotron absorption of electromagnetic waves in a plasma located in an inhomogeneous magnetic field. Skovoroda, A.A.; Shvilkin, B.N. (Moskovskij Gosudarstvennyj Univ. (USSR)). *Zh. Eksp. Teor. Fiz.;* 70: No. 5, 1779-1784(May 1976). (In Russian).

Results are presented of an experimental study of cyclotron absorption of electromagnetic waves in a plasma located in an inhomogeneous magnetic field. The experimental data are compared with the theoretical calculations in which electron-neutral atom collisions are taken into account. The comparison shows that the phenomenon can quite satisfactorily be described by the theory.

55443 Structure of a transverse shock wave in a plasma. Velikovich, A.L.; Liberman, M.A. (Institute of Physics Problems, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* 44: No. 4, 727-738(Oct 1976).

The structure of a shock wave front propagating in a fully ionized collision-dominated plasma perpendicular to the direction of the magnetic field is determined for arbitrary values of $\beta = 8\pi p/H^2$. It is shown that in the case of a magnetized plasma (Ω/sub i/tau/sub i/<1) the wave front structure is determined by the ion viscosity and by the dispersion due to inertia of the electrons. The dispersion is more important at small values of β, and the structure of the wave front consists of oscillations that decay behind the wave front. At finite values of β the shock wave front is monotonic. In a shock wave with a sufficiently big temperature discontinuity, however, dispersion predominates at the beginning of the front and leads to the appearance of decaying oscillations ahead of the shock wave front. The Alfven Mach numbers that are critical for the effect of dispersion are found. Dispersion due to electron inertia is not essential in the case of an unmagnetized plasma (Ω/sub e/tau/sub e/<1). The width of the shock wave front is determined by Joule dissipation. The values of the critical Mach number (M/sub a//sup h/(β) above which Joule dissipation is insufficient for a continuous transition from a state ahead of the shock wave front to a state behind it are found. An isomagnetic discontinuity is produced behind the shock wave front in this case. The structure of the isomagnetic discontinuity, which is determined by the electron thermal conductivity, ion viscosity, and ion thermal conductivity, is found.

55444 Spontaneous emission of electromagnetic waves by a semi-bounded non-equilibrium plasma. Yakimenko, I.P.; Zagorodny, A.G. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). *Phys. Scr.;* 14: No. 5, 242-252(Nov 1976).

The boundary value problem of an anisotropic plasma half-space excitation by the given space-time distribution of sources is solved. The energy relations are determined for the spontaneous emission from the semi-bounded non-equilibrium plasma. The generalization of the well-known results of classical radiation theory is established (in particular, Kirchhoff's law) for the case of non-equilibrium emission from a half-space of anisotropic plasma. The quasistatic surface excitation spectra are investigated in a one-component plasma with a low-density electron beam and in a non-isothermal electron-ion plasma with electron drift relative to the ions. The possible instability of such excitations and the anomalous effective temperature growth for the quasistationary part of the spontaneous field are shown. The threshold values of the electron beam velocities for various branches of the surface excitation are calculated.

55445 Influence of a circularly polarized electromagnetic wave on a magnetized plasma. Stenflo, L. (Umeaa Univ. (Sweden). Plasmafysiska Institutionen). *Phys. Scr.;* 14: No. 6, 320-323(Dec 1976).

A dispersion relation is derived for a magnetized plasma in which a large amplitude circularly polarized wave propagates along the external magnetic field. It is shown that new modes, which appear due to relativistic effects, can be unstable.

55446 Absorption of large-amplitude microwaves at intermediate frequencies. Budnikov, V.N.; Varfolomeev, V.I.; Novik, K.M. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* 22: No. 1, 28-31(Jan 1977).

Absorption of 10-cm microwave power at levels up to 5 kW is studied for a pulse length of 10 μsec in a plasma at frequencies ω/sub He/ <ω<√ω/sub He/ω/sub Hi/. In the experiments the working gas is argon at a pressure of 10^{-2} torr, the plasma density in the wave region is 10^{12} cm^{-3}, the electron temperature is 3 eV, and the magnetic field is about 2 kOe. Absorption occurs without any time lag if the density at the entrance point is an order of magnitude above the cutoff density. At this density the efficiency of low-power absorption reaches a maximum. At lower densities, there is a time lag in the absorption, during which a preliminary ionization occurs, apparently as a result of ordinary collisional absorption. The region in which the energy is absorbed is found with a movable double probe. At low power levels, below 30 W (v/sub E//v/sub T/4 x 10^{-3}), the absorption is confined to the vicinity of a singularity. At higher power levels the absorption region moves away from this singularity toward the entrance point; the absorption is anomalously rapid over a distance of several centimeters.

55447 Absorption of an electromagnetic pulse in a plasma. Plis, A.I.; Shcheglov, V.A. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* 22: No. 1, 39-42(Jan 1977).

The transport of monochromatic radiation in a plasma is analyzed. An exact analytic solution is found to describe the propagation of an electromagnetic signal under conditions such that the radiation is absorbed in collisions of electrons with ions and neutrals (atoms or molecules). Particular cases are analyzed.

55448 Stationary waves in a bounded plasma. Rutkevich, B.N.; Pashchenko, A.V.; Fedorchenko, V.D.; Mazalov, Y.P. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Kharkov). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* 22: No. 1, 63-67(Jan 1977).

Stationary space-charge waves in a thin plasma slab, a thin plasma rod, and a thin electron beam in a strong longitudinal magnetic field are analyzed. The analysis is based on the model of a thin plasma slab used previously for a cold plasma. When this model applies, the equations of motion for the electrons have stationary solutions corresponding to two wave branches which differ in propagation velocity and several other characteristics. Corresponding to these branches there are two branches of the small-amplitude dispersion curve. A nonlinear solution giving the wave profile and propagation velocity as functions of the amplitude is found for finite-amplitude waves. The exact equations are used to find a relationship between the propagation velocity and the amplitude for solitary space-charge waves; the maximum values of the electric potential and field are determined.

55449 Convective Brillouin amplification in a homogeneous plasma slab. Fuchs, V. (Hydro-Quebec, Montreal (Canada). Research Inst.). *Phys. Lett., A;* 59: No. 6, 455-457(10 Jan 1977).

The coupled-mode Brillouin backscatter equations, describing weakly nonlinear decay of a damped pump into two damped daughter waves, are solved analytically in the convective regime, yielding the convective instability threshold and backward amplification of a noise source.

55450 Ion acoustic waves in the presence of electron plasma waves. Michelsen, P.; Pecseli, H.L.; Ramussen, J.J. (Danish Atomic

Energy Commission, Risoe. Research Establishment). *Phys. Lett., A;* 59: No. 6, 445-447(10 Jan 1977).

Long-wavelength ion acoustic waves in the presence of propagating short-wavelength electron plasma waves are examined. The influence of the high frequency oscillations is to decrease the phase velocity and the damping distance of the ion wave.

55451 Observation of resonance and thermoelectric magnetic fields in a microwave-plasma interaction. Raven, A.; Rumsby, P.T. (Oxford Univ. (UK). Dept. of Engineering Science). *Phys. Lett., A;* 60: No. 1, 42-44(24 Jan 1977).

Experimental evidence has been obtained for generation of polarisation dependent magnetic fields in the interaction of an obliquely incident microwave beam with an inhomogeneous, overdense, slab plasma. This is discussed in relation to observed particle emission and resonance absorption.

FUSION POWER PLANTS

REFER ALSO TO CITATION(S) 53705

55452 (EPRI-ER—289(Vol.1)) **Experimental fusion power reactor conceptual design study. Final report. Volume I.** Baker, C.C. (General Atomic Co., San Diego, Calif. (USA)). Dec 1976. 288p. Dep. NTIS, PC A13/MF A01.

This document is the final report which describes the work carried out by General Atomic Company for the Electric Power Research Institute on a conceptual design study of a fusion experimental power reactor (EPR) and an overall EPR facility. The primary objective of the two-year program was to develop a conceptual design of an EPR that operates at ignition and produces continuous net power. A conceptual design was developed for a Doublet configuration based on indications that a noncircular tokamak offers the best potential of achieving a sufficiently high effective fuel containment to provide a viable reactor concept at reasonable cost. Other objectives included the development of a planning cost estimate and schedule for the plant and the identification of critical R and D programs required to support eh physics development and engineering and construction of the EPR. This volume includes descriptions of systems design, reactor physics, and nucleonics. (MOW)

55453 (EPRI-ER—289(Vol.2)) **Experimental fusion power reactor conceptual design study. Final report. Volume II.** Baker, C.C. (General Atomic Co., San Diego, Calif. (USA)). Dec 1976. 372p. Dep. NTIS, PC A16/MF A01.

This document is the final report which describes the work carried out by General Atomic Company for the Electric Power Research Institute on a conceptual design study of a fusion experimental power reactor (EPR) and an overall EPR facility. The primary objective of the two-year program was to develop a conceptual design of an EPR that operates at ignition and produces continuous net power. A conceptual design was developed for a Doublet configuration based on indications that a noncircular tokamak offers the best potential of achieving a sufficiently high effective fuel containment to provide a viable reactor concept at reasonable cost. Other objectives included the development of a planning cost estimate and schedule for the plant and the identification of critical R and D programs required to support the physics development and engineering and construction of the EPR. This volume contains the following sections: (1) reactor components, (2) auxiliary systems, (3) operations, (4) facility design, (5) program considerations, and (6) conclusions and recommendations.

55454 (EPRI-ER—289(Vol.3)) **Experimental fusion power reactor conceptual design study. Final report. Volume III.** Baker, C.C. (General Atomic Co., San Diego, Calif. (USA)). Dec 1976. 208p. Dep. NTIS, PC A10/MF A01.

This document is the final report which describes the work carried out by General Atomic Company for the Electric Power Research Institute on a conceptual design study of a fusion experimental power reactor (EPR) and an overall EPR facility. The primary objective of the two-year program was to develop a conceptual design of an EPR that operates at ignition and produces continuous net power. A conceptual design was developed for a Doublet configuration based on indications that a noncircular tokamak offers the best potential of achieving a sufficiently high effective fuel containment to provide a viable reactor concept at reasonable cost. Other objectives included the development of a planning cost estimate and schedule for the plant and the identification of critical R and D programs required to support the physics development and engineering and construction of the EPR. This volume contains the following appendices: (1) tradeoff code analysis, (2) residual mode transport, (3) blanket/first wall design evaluations, (4) shielding design evaluation, (5) toroidal coil design evaluation, (6) E-coil design evaluation, (7) F-coil design evaluation, (8) plasma recycle system design evaluation, (9) primary coolant purification design evaluation, (10) power supply system design evaluation, (11) number of coolant loops, (12) power conversion system design evaluation, and (13) maintenance methods evaluation.

55455 (JAERI-M—6666) **JT-4 program.** (Japan Atomic Energy Research Inst., Tokyo). Aug 1976. 265p. (In Japanese). Dep. NTIS (US Sales Only), PC A12/MF A01.

Design studies made on JT-4 since April 1975 are summarized. JT-4 is a tokamak device with non-circular cross section and axisymmetric divertors. Contents are the purpose of JT-4, basic design, results of the preliminary design by three manufactures, diagnostics, further heating, and flow charts of the JT-4 program.

55456 (JAERI-M—6670) **Preliminary design of an experimental fusion reactor. Interim report.** (Japan Atomic Energy Research Inst., Tokyo). Aug 1976. 193p. (In Japanese). Dep. NTIS (US Sales Only), PC A09/MF A01.

A preliminary design of a tokamak experimental fusion reactor to be built in the near future is under way. The goals of the reactor are to achieve reactor-level plasma conditions for a sufficiently long operation period and to obtain design, construction and operational experience for the main components of full-scale power reactors. This design covers the plasma characteristics, reactor structure, blanket neutronics, shielding, superconducting magnets, neutral beam injector, electric power supply system, fuel recirculating system, reactor cooling system and tritium recovery system of the reactor. The main design parameters are as follows; the reactor fusion power 100MW, torus radius 6.75m, plasma radius 1.5m, first wall radius 1.75m, toroidal magnetic field on axis 6T, blanket fertile material Li_2O, coolant He, structural material 316SS and tritium breeding ratio 0.8.

55457 (KURRI-TR—140, pp 3-16) **Present state of research and development of nuclear fusion reactors and future problems.** Sekiguchi, T. (Tokyo Univ. (Japan). Faculty of Engineering). 1975. (In Japanese).

From Study meeting on radiation damage of fusion reactor materials; Kumatori, Osaka, Japan (10 Sep 1974).

In Report of the study meeting on radiation damage of fusion reactor materials.

The realization of so-called zero-power reactor or critical plasma testing facility is the first barrier to get over for the realization of power reactors in the research and development of controlled nuclear fusion power, and full efforts are exerted to it in each country. Now the stage to demonstrate from pure scientific standpoint the realizability of core plasma in view of energy balance is beginning. This tendency has been fomented by promising experimental results with Tokamak type torus plasma facilities, and efforts are exerted to establish the scaling law by clarifying the properties of superhigh temperature core plasma, to compare the features and relative superiority of Tokamak and other plasma-generating and containing types, and to decide the candidate of the core type for power reactors. In the Tokamak type facilities, the increase of the dimensions and magnetic field of the facilities, the temperature raising by second stage heating such as the injection of high energy neutral particles, and the improvement of plasma stability by means of noncircular plasma cross section are under consideration. Recently the conceptual design of whole reactors has been carried out in U.S.A. In the research and development of nuclear fusion, many scientific and technical trials and errors are necessary, accordingly the researchers should be courageous and flexible.

55458 (ORNL—5275) **Fusion Energy Division annual progress report for period ending December 31, 1976.** (Oak Ridge National Lab., Tenn. (USA)). Jun 1977. Contract W-7405-ENG-26. 315p. Dep. NTIS, PC A15/MF A01.

Separate abstracts were prepared for 8 of the included sections. (MOW)

55459 (ORNL—5275, pp 223-250) **Next step (TNS) program.** Roberts, M.; Attenberger, S.E.; Ballou, J.K. Jun 1977.

In Fusion Energy Division annual progress report for period ending December 31, 1976.

Following the initial exploratory phase in which a succession of Reference Points was evolved and key engineering issues considered, a broad design space investigation was undertaken. Achievement of this design basis is being pursued in an integrated program consisting of four main parts. (1) A trade study evaluation to support a plasma size and toroidal field coil technology decision, (2) impurity control and poloidal field winding locations, and (3) R and D programs to identify available and required experimental support basis.

55460 Controlled fusion in Germany. Running activities and future program. Danner, W.; Schmitter, K.H. (Max-Planck-Institut fuer Plasmaphysik , Garching, Ger.). pp 483-491 of In 1976 ASME-ANS international conference on advanced nuclear energy systems. New York; American Society of Mechanical Engineers (1976).

The main items of the German Fusion Program are described. Within the next five-year plan emphasis is placed on physics research, especially on the tokamak line which will be supplemented by stellarator and high-β experiments. Technological development is concentrated on superconducting magnets and heating and refuelling systems to support plasma physics advance. In the reactor oriented part of the program, systems studies play the major role. Further work will predominantly be performed in the fields of material sciences and tritium technology, which are considered to be indpendent of a special confinement scheme.

55461 Experiments on non-circular tokamak and related topics. Toyama, H.; Inoue, S.; Itoh, K.; Iwahashi, A.; Kaneko, H.; Makishima, K.; Ochiai, I.; Shinohara, S.; Suzuki, Y.; Yoshikawa, S. (Tokyo Univ. (Japan). Dept. of Physics. pp 323-334 of In Plasma physics and controlled nuclear fusion research 1976. Vol. I. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

Active control of the cross-sectional shape of plasma has been carried out in the non-circular tokamak TNT and the modified device TNT-A; D-shaped, elongated plasma equilibria have been obtained with considerably low safety factors (2-5). The relation between n-index and elongation degree has been studied. MHD properties of the elongated plasma have been found similar to those of circular tokamaks. In relation to these results, MHD properties inside the plasma have been studied in detail, using a small-scale tokamak with a circular cross-section. The direct measurement of the m=2 magnetic island structure is reported. To complement these experiments, some theoretical work has been done: kink instabilities have been analysed for various current distributions; the resonant interaction of the plasma with the external helical winding has been studied; and the stability of the m=n=0 mode coupled non-linearly with a higher kink mode has been investigated. This non-linear mechanism explains one type of disruptive instability.

PHYSICS AND BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 55255, 55311, 55339

55462 (IPP—6/147, pp v) **Effects of impurity transport on neutral injection in Tokamaks.** Hughes, M.H. (UKAEA Research Group, Abingdon. Culham Lab.). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

4 figs.; 5 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session G: Transport in laboratory plasmas. G 2.

A 1-D radial transport code is used to examine the possible effects of impurity accumulation on high energy neutral injection heating in a Tokamak.

55463 (IPP—6/147, pp v) **Influence of neutral injection on impurity transport in TEXTOR.** Nicolai, A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Plasmaphysik). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

3 figs.; 10 refs.

In Computing in plasma physics and astrophysics. Proceedings. Poster session. P 2.

Reversal of the impurity flux as a possible means to avoid large impurity concentrations in a Tokamak plasma has been discussed already in several papers. Flux reversal can in principle be obtained a) by additional heating, either R.F. heating or neutral injection, leading to a steepening of the ion-temperature profile and thus to an enhancement of the thermal diffusion b) by influx or neutral gas from the outside. In the following the combined effects of additional heating by neutral injection and of neutral gas influx on the impurity transport in a Tokamak plasma (TEXTOR) is considered as well as, for comparsion, the effect of each measure alone.

55464 (JAERI-M—6684) **Fundamentals of fusion reactor blanket chemistry, 1. Summary.** Furukawa, K. (Japan Atomic Energy Research Inst., Tokyo). Aug 1976. 25p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

In constituting the concept of a nuclar fusion reactor, comprehensive study of the blanket chemical behavior of reactor materials including nuclear-chemical and tritium-chemical aspects is necessary, along with the neutron-physical study and ahead of the nuclear engineering consideration. This report summarizes the criteria for problems treated in the subsequent parts. Problems are the selections of blanket structural material, tritium-fertile material, and also the methods of tritium separation, environmental-release protection and energy conversion.

55465 (JAERI-M—6726) **Neutronics design of fusion reactors and application of blanket neutronics experiment to the design.** Seki, Y. (Japan Atomic Energy Research Inst., Tokyo). Oct 1976. 145p. (In Japanese). Dep. NTIS (US Sales Only), PC A07/MF A01.

A conceptual design of a commercial fusion power reactor and a preliminary design of an experimental fusion reactor are under way. Based on the experience of the neutronics of the two reactors, the status of neutronics design and problems in the neutronics calculation are described. A series of blanket neutronics experiments has been carried out to examine validity of the nuclear data and calculation methods used in neutronics design of the fusion reactors. The measured fission-rate distributions in the four types of spherical blanket assemblies consisting of lithium and/or graphite and/or natural uranium are analyzed. The effects of uncertainty of the nuclear data, processing procedure of the multi-group cross sections, and approximations in neutron transport calculations upon the calculated fission-rates are investigated. The discrepancy between the calculated and measured values of fission-rates is caused mainly by neglecting the anisotropy of secondary neutrons from inelastic and (n,2n) reactions in the multi-group cross section calculation. The results of the analysis are applied to the neutronics design of the fusion reactors to evaluate the effect of the results upon the blanket nuclear characteristics. In consequence, the substitution of the reflector material, graphite by stainless steel is recommended. It is also pointed out that the present shielding design for the superconducting magnets may be insufficient and increased attenuation may be necessary.

55466 (JAERI-M—6777) **Monte Carlo analysis of the neutral particle transport in torus plasma.** Inoue, S.; Suzuki, T.; Taji, Y.; Nakahara, Y. (Japan Atomic Energy Research Inst., Tokyo). Nov 1976. 30p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

In applying Monte Carlo method to analysis of the transport in torus plasma of neutral particles emitted from an isotropic source on the plasma surface or injected from a beam source, the analogy between neutron and neutral transport is utilized assuming that the plasma remains in steady state. The routine TORUS GEOM developed which deals with the transport in the torus geometry is incorporated in the neutron and gamma-ray transport Monte Carlo code MORSE. A method of sampling of the flight path in the torus geometry is described, and it is explained how to use the computer code. As examples, the energy distributions of neutral particles in and leaked from the plasma column and the spatial distribution in the plasma are calculated for both isotropic and beam sources. The results are described in relation of the torus geometry. In addition, the examination is carried out on the accuracy and applicability of the cylindrical approximation.

55467 (KURRI-TR—140, pp 38-43) **Some chemical ploblems of the blanket materials for fusion reactors.** Furukawa, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). 1975. (In Japanese).

From Study meeting on radiation damage of fusion reactor materials; Kumatori, Osaka, Japan (10 Sep 1974).

In Report of the study meeting on radiation damage of fusion reactor materials.

The chemical problems of blanket materials are reviewed and discussed from the viewpoint of the practical use in D-T fusion power reactors. The expected functions of the materials and the expected phenomena occurring in the materials are briefly reviewed in the first part. Secondly, many possible materials are listed together with their neutron capture cross sections and physical properties. The merits and demerits of these materials are discussed on the basis of their chemical and neutron properties, and some promising materials are proposed among both liquid and solid materials. In the third part, regarding solid blanket materials, their general merits and many unresolved problems are specially discussed in association with especially the use of lithium oxide which seems now to be most promising. The same discussion is made on liquid blanket materials. Some detailed evaluation of typical liquid materials, namely liquid Li and lithium fluoride, is also carried out from the viewpoints of practical use in power reactors. Finally, the author points out some aspects which should receive more attention.

55468 Wall analysis in Pulsator I. Staib, P.; Staudenmaier, G. (Max-Planck-Institut fuer Plasmaphysik, Munich). *J. Nucl. Mater.;* **63**: 37-46(1976).

The amount of impurities deposited during the discharge on samples introduced to the liner of PULSATOR I has been measured using a combination of several surface physics techniques (AES, SIMS, EID, RIBS). The amounts are absolutely calibrated and are about 2×10^{13} atoms/cm^2 for oxygen, 5×10^{12} atoms/cm^2 for Fe, Cr, Ni (liner material) and 2×10^{12} atoms/cm^2 for Mo (limiter material). They depend strongly on the kind of discharges and on the position of the sample. First results using a shutter for time resolved exposure of the sample indicate that deposition of impurities takes place during the plateau of the discharge.

55469 Neutronics and photonics studies for the University of Wisconsin laser fusion reactor blanket. Cheng, E.T.; Ragheb, M.M.H.; Conn, R.W. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.;* **26**: 504-506(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55470 Scoping studies of blanket designs for a power-generating laser fusion hybrid reactor. Hansen, L.F. (Univ. of California, Livermore); Holman, R.R.; Maniscalco, J.A. *Trans. Am. Nucl. Soc.;* **26**: 506(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55471 Two-dimensional neutronics model for major penetrations in tokamaks. Jung, J.; Abdou, M.A. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **26**: 506-508(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55472 Observation of electrodisintegration neutron production in the Princeton Large Tokamak. Strachan, J.D.; Jassby, D.L. (Princeton-Plasma Physics Lab., NJ). *Trans. Am. Nucl. Soc.;* **26**: 509-510(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55473 Simulation of fusion reactor neutronics using low-energy neutron sources. Filippone, W.L.; Martin, J.G.; Duggan, C.; Harrington, M. (Univ. of Lowell, MA). *Trans. Am. Nucl. Soc.;* **26**: 510-511(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55474 Energy multiplication and tritium breeding in light-water hybrid reactors (LWHR). Greenspan, E.; Schneider, A.; Misolovin, A.; Gilai, D. (Nuclear Research Center-Negeb, Beersheba, Israel). *Trans. Am. Nucl. Soc.;* **26**: 511-512(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 55497

55475 (BNL—22667) **Safety and reliability aspects of superconducting magnets for thermonuclear power reactors.** Powell, J.R.; Hsieh, S.Y.; Lehner, J.; Reich, M.; Danby, G.; Prodell, A. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 19p. (CONF-770618—1). Dep. NTIS, PC A02/MF A01.

From World electrotechnical congress; Moscow, Union of Soviet Socialist Republics (USSR) (21 Jun 1977).

Four accident classes for fusion magnet systems with examples of upper bounds on probability of occurrence are described. Some potential accident sequences are discussed. The mechanical, thermal, and electrical aspects of magnet safety and reliability are reviewed. (MOW)

55476 (IPP—6/147, pp v) **Diffusive transition from belt pinch to doublet.** Grad, H.; Hu, P.N.; Stevens, D.C.; Turkel, E. (New York Univ., N.Y. (USA). Courant Inst. of Mathematical Sciences). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

4 figs.; 5 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session G: Transport in laboraty plasmas. G 4.

A complete analytical and numerical treatment has been given, including creation and development of islands (as in Doublet) using a generalization of the concept of adiabaticity to treat mixing and splitting of islands.

55477 (IPP—6/147, pp v) **Two dimensional modeling of Tokamaks.** Klein, H.H.; Byrne, R.N.; Krall, N.A. (Science Applications, Inc., La Jolla, Calif. (USA)). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

1 fig.; 3 refs.

In Computing in plasma physics and astrophysics. Proceedings. Poster session. P 1.

The code G2M is used to calculate the diffusion stages of Tokamak discharges as described by Grad and Hogan. The Pfirsch-Schlueter transport coefficients given by Hazeltine and Hinton are used in a calculation of separatrix formation.

55478 (JAERI-M—6671) **Determination of the current density in a superconducting magnet viewed in the protection.** Shimamoto, S. (Japan Atomic Energy Research Inst., Tokyo). Aug 1976. 6p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

The protection system partly determines the current density in a superconducting magnet. In calculation, it is assumed that there is no cooling of the magnet. When the protection resistance is put immediately after beginning of the normal transition, the temperature in the normal region increases with time. For a given stored energy in the magnet, the effect of the resistance in the temperature rise is also shown.

55479 (JAERI-M—6689) **Experiments with a resistive model shell for tokamak apparatus.** Sometani, T.; Fujisawa, N. (Japan Atomic Energy Research Inst., Tokyo). Aug 1976. 19p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The distribution of image current (shell current) in a resistive model shell has been measured. A plasma simulator is set in the shell; it is fed with a sinusoidal current of variable frequency. The distributions of shell current at different frequencies are obtained, following the Ampere's law, from signals of the magnetic probes located on internal and external surfaces of the shell. Intensity of the shell current increases as the simulator is displaced outward and the frequency is raised. Intensity of the shell current does not vary as a sinusoidal function of the poloidal angle of the shell. When frequency of the simulator current is raised sufficiently to make thickness of the shell equal to its skin depth, intensity of the shell current becomes independent of the frequency. The vertical magnetic field produced by the shell current is obtained from signals of the magnetic probes located on the simulator. Intensity of the measured field coincides with that of the vertical magnetic field calculated with the measured distribution of shell current. The current densities on internal and external surfaces of the ideal model shell are also measured.

55480 (Juel—1349) **Large magnetic coils-design accompanying calculation and optimization. Regarding orthotropic interlayers, temperature and elastic supports-derivation of a special finite element. The TEXTOR project.** Stelzer, J.F.; Sievers, A.; Welzel, R. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralabteilung Allgemeine Technologie). Oct 1976. 80p. Dep. NTIS (US Sales Only), PC A05/MF A01.

16 refs.; 9 tabs.; with figs.

This paper deals with finite element calculations of large coils as they are used as main coils in Tokamaks. They consist of copper layers with glass fibre reinforced resin interlayers inbedded in a strong steel ring. In a first analysis model the several epoxy layers are condensed to only one the tickness of which is equal to the sum of the single sizes. This fictitious layer is assumed to lie in the middle of the copper and is treated as an orthotropic material. In a following changed model the epoxy layer is situated between the steel ring and the copper. In this location the epoxy was suspected to suffer from the highest shear stresses. Both models employ springy trusses as supporting features which simulate the real elastic behaviour of a sustaining vault. Special attentions are given a) to the shear stresses in the epoxy, b) to the hot and cold states of the coils, and c) to the forces transferred from the coils to the sustaining vault. An optimal structure design is carried out concerning the steel ring.

55481 (KFTI—76-15) **Mechanical stresses and deformation in the main frame of stellarator helical windings.** Biryukov, O.V.; Tkhoryak, F.A.; Uglitskii, N.F. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1976. 52p. (In Russian). Dep. NTIS (US Sales Only), PC A04/MF A01.

9 refs.; 37 figs.

The technique for calculating strength and rigidity of magnetic system components in the stellarator-type electrophysical devices is described. A computational error is estimated with regard to the aspect ratio. The error is shown not to exceed 0.28% with $R/r < 2$. The frame of a helical winding made of glass plastic and steel is calculated. It was obtained by power winding technique. The results are summarized and presented as graphs and tables to help the engineer. The method of determining the modulus of elasticity for stretching and contraction of the glass plastic using annular specimens is described.

55482 (KURRI-TR—140, pp 44-48) **Radiation effect of superconducting magnet materials for fusion reactors.** Okada, T. (Osaka Univ., Suita (Japan). Faculty of Engineering). 1975. (In Japanese).

From Study meeting on radiation damage of fusion reactor materials; Kumatori, Osaka, Japan (10 Sep 1974).

In Report of the study meeting on radiation damage of fusion reactor materials.

The effects of neutron irradiation on Nb-Ti wire were studied, using the experimental reactor KUR. In the first part, the significance of superconducting magnets for fusion power reactors is explained together with the outline of the recent conceptual design of fusion reactors. In the second part, some results of the neutron irradiation experiment performed on the Nb-Ti materials (Nb-59.8 a/o Ti and Nb-47.6 a/o Ti) stabilized with copper are presented. Taking neutron irradiation as a parameter, some important parameters such as critical current density and critical temperature were obtained as the functions of aging time. Based on these results, the effects of neutron irradiation are discussed. Finally, the developmental efforts to be exerted hereafter are summarized.

55483 (N—77—17850) **Calculation of the magnetic field, magnetic forces and behavior of large coil systems for fusion experiments.** Preis, H. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Feb 1977. Contract NASW-2790. 98p. (NASA-TT-F—17382). NTIS, PC A05/MF A01.

Calculation methods for use in the designing of large field coil assemblies for Tokamak type fusion experiments are described. In these methods the winding form of the coil is approximated by a large number of infinitely thin conducting filaments, thereby facilitating the calculation of field parameters and the mapping of field lines. The calculations are coded as a unified set of FORTRAN programs with an error less than 1%. The behavior of the toroidal system in case of a coil short is also analyzed; it is shown how the resultant forces exerted on the field coils can be reduced by circuit modification.

55484 (ORNL—5275, pp 199-221) **Magnetics and superconductivity section.** Lubell, M.S.; Akin, J.E.; Alley, L. Jun 1977.

In Fusion Energy Division annual progress report for period ending December 31, 1976.

Research progress during this period is reported under one of the following areas: (1) design projects, (2) small scale experiments, (3) large coil experiments, (4) projects based on disciplines, and (5) projects requiring work by subcontractors. (MOW)

55485 (ORNL—5275, pp 273-288) **Large coil program.** Luton, J.N.; Nelms, L.W.; Thompson, P.B. Jun 1977.

In Fusion Energy Division annual progress report for period ending December 31, 1976.

Separate discussions are given for each of the following topics: (1) objectives and plan, (2) EPR toroidal magnet studies, (3) test coil size and shape, (4) test conditions and arrangement, and (5) test coil specifications. (MOW)

55486 Reconnection of field lines and disruptive instability in tokamaks. Kadomtsev, B.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 555-565 of In Plasma physics and controlled nuclear fusion research 1976. Vol. I. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

It is well known that the disruptive instability in tokamkas is a rapidly developing process involving a redistribution of current over the column coss-section with a decrease in poloidal field energy and an expulsion of part of the poloidal flux beyond the boundary of the column. In the present paper, this process is interpreted as a sequence of reconnections of field lines inside the column. In the present paper, this process interpreted as a sequence of reconnections of field lines inside the column. The reconnection process by the m=1, n=1 mode, previously described by the author for an internal disruptive instability, is extended to a disruptive instability of general form, in which there may be no helical symmetry. It is shown that in the field line reconnection process, an invariant exists which is similar to that previously introduced by J.B. Taylor. If the reconnection process is free, the drop of the poloidal field energy for the case Bsub(Z) much < Bsub(theta) (the tokamak condition) leads to a uniform distribution of the current density jsub(Z)=const. Part of the poloidal flux may be ejected beyond the limiter, corresponding to a negative spike on the voltage. Thus, the free reconnection process in a tokamak resembles MHD turbulence in a diffusion pinch, turbulence which in the latter case leads to a force-free field distribution. As compared to zeta plasma, the tokamak plasma is in a state of intermittence, so that the turbulence flares up only during the disruptive instability. Actually, the reconnection process in a tokamak does not develop with complete freedom since only a limited number of modes can be excited. A qualitative examination o the mode interaction mechanism shows that the most probable start forthe development of disruptive instability are the interacting m=1 and m=2 modes which build up simultaenously.

55487 Formation of closed magnetic field line plasma systems using intense relativistic electron beams. Hammer, D.A.; Robson, A.E.; Gerber, K.A. (Naval Research Lab., Washington, D.C. (USA)). *Phys. Lett., A;* **60**: No. 1, 31-33(24 Jan 1977).

Closed magnetic field plasma confinement geometries produced by plasma currents induced by rotating intense relativistic electron beams are discussed conceptually. Experimental evidence for the formation of such layers is presented.

POWER SUPPLIES AND CIRCUITRY

55488 (JAERI-M—6646) **Engineering problems in D.C circuit breakers.** Shimada, R.; Tani, K.; Tamura, S.; Kobayashi, T.; Kobayashi, T. (Japan Atomic Energy Research Inst., Tokyo). Aug 1976. 27p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

A two-year research and development program(1975-1976) to develop high current circuit breakers for JT-60 is proceeding in JAERI. Engineering problems particularly in the vacuum breaker are described.

55489 (JAERI-M—6762) **Delay circuit for constant current operation of JFT-2.** Maeno, M.; Matsuzaki, Y.; Fujisawa, N. (Japan Atomic Energy Research Inst., Tokyo). Oct 1976. 14p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

A delay circuit has been designed and used in tokamak JFT-2 for its constant plasma current operation. Such delay circuit usually consists of numbers of equal solenoid coils and capacitors. In the circuit developed, its last element is the primary winding of JFT-2 itself, of which the inductance is much larger than those of the preceding solenoid coils. In this way, the size of the solenoids can be small and the circuit be compact. Experimental constant current operation was performed after baking the vacuum wall and discharge cleaning; the plasma current was then constant with an anticipated flat-top duration.

55490 (SAND—77-0174) **Preliminary design of a 100 Hz, 350 kV short pulse generator.** Rohwein, G.J.; Buttram, M.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 46p. Dep. NTIS, PC A03/MF A01.

This report describes a 350 kV pulser designed to generate 100 ns square pulses with 300 joules total energy at a pulse repetition frequency of 100 per second. This design incorporates a transformer charged helical coaxial pulse forming line. The considerations leading to this design are presented together with results from prototype experiments. The pulser which is presently in the construction and testing phase is described in detail. The pulser will be used for electron beam acceleration.

FUEL SYSTEMS

REFER ALSO TO CITATION(S) 55240

55491 (JAERI-M—6778) **Pulsed gas feed to the ion source.** Tanaka, S.; Shibata, T. (Japan Atomic Energy Research Inst., Tokyo). Nov 1976. 12p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

Hydrogen gas feed to the ion source of a neutral beam injector for the JFT-2 tokamak has been pulsed by a set of gas reservoir, solenoid valve and variable leak. During the pulse width the flow rate is constant except for its initial overshoot. After detailed study of the temporal behaviour, the solenoid valve and variable leak were replaced with a piezo-electric valve, resulting in improvement of the rise and decay.

55492 (ORNL—5275, pp 167-198) **Plasma heating and fueling section.** Stewart, L.D.; Schilling, G. Jun 1977.

In Fusion Energy Division annual progress report for period ending December 31, 1976.

The Plasma Heating and Fueling Section has the responsibility for developing neutral beam injection heating and pellet fueling techniques. Progress in 1976 occurred on several fronts. The Medium Energy Systems Test Facility became operational in November with two Princeton Large Torus (PLT) beam line systems; it is expected that the first two beam lines will be installed on PLT in early 1977. The original conceptual design for the much larger Tokamak Fusion Test Reactor (TFTR) neutral beam systems was considerably revised, and an updated proposal was submitted to Princeton Plasma Physics Laboratory (PPPL) in December. The 150-keV Test Facility, a prototype for the TFTR systems, was completed in October and has been operated at 120 keV and 30 mA with a two-stage system. Operation at high currents will be possible after checkout of the power supply is complete. The 10-cm and 15-cm sources on the Oak Ridge Tokamak (ORMAK) operated throughout the year, and 500 kW of injected power was achieved. Frozen hydrogen pellets of 210-μm diam were also successfully injected into ORMAK.

55493 (UCRL—78865) **Equilibrium constants for the hydrogen isotopic self-exchange reactions in the 4.2-50.0 K temperature range.** Pyper, J.C.; Souers, P.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Dec 1976. Contract W-7405-ENG-48. 16p. (CONF-770801—1). Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Boulder, Colorado, United States of America (USA) (2 Aug 1977).

Hydrogen fusion will require a mixture of liquefied or frozen D_2 and T_2. The equilibrium constant of the mixture describes the composition of this fuel. We have calculated the equilibrium constant, K/sub DT/, for the reaction $D_2 + T_2 = 2DT$ in the 4.2-100 K temperature range. The results agree well with previous calculations at 25, 50, and 100 K. No calculations at temperatures below 25 K have been previously published. In the 16.7 to 33.3 K temperature range, which includes the triple point, K/sub DT/ can be represented by K = 2.995 exp [-10.82/T]. The values of the analogous equilibrium constants for H_2—D_2 and H_2—T_2 are also given in the 4.2 to 50 K temperature range.

55494 **Fueling by plasma guns.** Marshall, J. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* 26: 14(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

RADIATION HAZARDS

55495 (HMI-B—213) **Tritium in a thermal blanket of a fusion reactor.** Altenhein, F.K.; Andresen, H.; Gruber, J.; Lutze, W.; Migge, H. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.). Bereich Kernchemie und Reaktor). Oct 1976. 101p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

74 refs.; with figs. and tabs.

The paper calculates tritium sources, inventories and emission rates of D-T fusion reactors and deals with tritium distribution due to permeation and diffusion, with tritium chemistry and with problems of tritium containment. Since calculations and considerations cannot be considered out of concept in many cases, a thermal blanket with helium cooling is used as example. The characteristics of this blanket are illustrated by comparisons with other blanket layouts.

55496 **Tritium handling scheme for the JET experiment.** Clerc, H.; Venus, G. (Culham Lab., Abingdon, Eng.). pp 359-365 of In Ninth symposium on fusion technology. Oxford; Pergamon Press (1976).

If in JET the plasma performance during the first stage of conventional experiments proves successful, studies of nuclear heating will be performed with a mixture of deuterium-tritium as filling gas. Provisions for the future use of tritium have to be made now to make the later transition as smooth as possible. Therefore the aspects of the use of tritium have been studied and the results of these studies are presented.

POWER CONVERSION SYSTEMS

55497 (JAERI-M—6783) **Evaluation of shielding design for superconducting magnets, (3). Shielding design of the experimental fusion reactor.** Seki, Y.; Iida, H.; Ide, T. (Japan Atomic Energy Research Inst., Tokyo). Nov 1976. 69p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

Shield for superconducting magnets in the experimental fusion reactor being designed in JAERI has been evaluated. The preliminary shield design was modified so as to meet the design criteria. Applicability of the one-dimensional calculation model for shielding design of the superconducting magnets was studied; the cylindrical model is found to be appropriate. As for the biological shield, a concrete layer of thickness 2m is sufficient for the secondary biological shield.

INERTIAL CONFINEMENT SYSTEMS

REFER ALSO TO CITATION(S) 55387, 55490

55498 (AD-A—038533) **Production of large warm plasmas by staged laser heating of solid targets. Memorandum report.** Pechacek, R.E.; Greig, J.R. (Naval Research Lab., Washington, D.C. (USA)). Feb 1977. 19p. (NRL—3457). NTIS PCA02/MF A01.

A 1000 Joule CO2 laser pulse, focussed on a slowly expanding (dr/dt = 200,000 cm/sec) gas cloud in a vacuum chamber, ionizes the gas by laser spark breakdown, and then heats it by inverse bremstrahlung absorption. The resulting plasma contains about 10 to the 19th power ions at a temperature of approximately 50 eV. The gas cloud is created by irradiating a solid plastic target with a 10 J prepulse and a 100 J main pulse from a Nd/glass laser. Two advantages of these two laser plasma production systems over irradiating a solid target directly with the CO2 laser are (1) the density of the target gas cloud in an adjustable parameter that can be used to vary the plasma temperature and total number of particles, and (2) since the temperature of an expanding plasma decreases as T(r) = (T sub o)((r sub o)/r) squared, and since r sub o is a factor of ten larger for a gas than a solid, the temperature at large r of a plasma that originated as a cloud is a factor of 100 higher than one that was heated at the radius of a solid, provided of course, that the initial temperature and particle number are the same in both cases. (Author)

55499 (AD-A—038555) **STREAM: a three-dimensional Monte Carlo ray-tracing code in cylindrical geometry. Final report.** Justice, J.A. (Air Force Weapons Lab., Kirtland AFB, N.Mex. (USA)). Feb 1977. 23p. (AFWL-TR—76-206). NTIS PCA02/MF A01.

This report is a user's guide for STREAM, a code used to theoretically model light transmission through complex, cylindrically symmetric SHIVA-type chamber geometries. Code access at the Air Force Weapons Laboratory (AFWL) and program INPUT are described in detail. Sample output is provided. (Author)

55500 (CONF-770611—8) **Electron beam technology and electron-beam target experimental results.** Toepfer, A.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 6p. Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; New York, New York, United States of America (USA) (12 Jun 1977).

Results are given of beam-target interaction experiments which study the coupling of intense charged particle beams with dense matter to provide a physics base for inertial confinement fusion (ICF) target design. The feasibility of ICF using the resulting target designs is studied. (MOW)

55501 (COO—4029-3) **Exploratory development of fusion cast calcium fluoride for 1.06 micrometer pulsed laser optics. Progress report, December 25, 1976—March 25, 1977.** Willingham, C.B. (Raytheon Co., Waltham, Mass. (USA). Research Div.). Apr 1977. Contract EY-76-C-02-4029. 25p. Dep. NTIS, PC A02/MF A01.

This program is an assessment of fusion cast polycrystalline calcium fluoride for optical components of 1.064 micrometer pulsed laser fusion systems. Task areas include casting of essentially stress-free 33 centimeter diameter, 5 centimeter thick ingots, developing surface finishing techniques for optically figured plane and spherical surfaces, and evaluating state-of-the-art antireflection coatings deposited onto specimens of the cast material. During the third quarter, three casting runs were completed in the large casting furnace, none of which was wholly successful. A decision to limit the remainder of the casting effort to six-inch (15-centimeter) diameter pieces was made. Two chemically homogeneous castings of CaF_2/Nd were made in a second furnace. Diamond abrasive polishing techniques were used successfully to fabricate a 15-centimeter radius convex spherical surface on one polycrystalline casting and a quarter wave plane surface on a second. Both surfaces were free of grain boundary relief which is commonly produced by standard techniques. Antireflection coatings obtained from two vendors were found to be physically durable and optically uniform. The components of these coatings are those also used by the vendors for their laser damage resistant coatings on glass, so it is reasonable to anticipate that they will be damage resistant on the fluoride as well. Damage testing will be carried out during the final quarter of the program.

55502 (IPP—6/147, pp v) **Simple routine for reaction products transport in laser-produced plasma.** Krumbein, A.D.; Rosenblum, M.; Zmora, H. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center); Kelson, Y. (Tel Aviv Univ. (Israel)). Apr 1976.

From 2. European conference on computational physics; Garching, German, Federal Republic of (F.R. Germany) (27 Apr 1976).

2 figs.; 3 refs.

In Computing in plasma physics and astrophysics. Proceedings. Session G: Transport in laboratory plasmas. G 6.

A simple trace tracking routine for charged particle reaction products has been developed as part of a one-dimensional spherical hydrodynamic laser simulation code. This routine calculates the spatial dependence of the energy deposition inside the pellet and the energy spectrum of those particles which escape.

55503 (JAERI-M—6616) **Self-similar analysis of the spherical implosion process.** Ishiguro, Y.; Katsuragi, S. (Japan Atomic Energy Research Inst., Tokyo). Jul 1976. 33p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The implosion processes caused by laser-heating ablation has been studied by self-similarity analysis. Attention is paid to the possibility of existence of the self-similar solution which reproduces the implosion process of high compression. Details of the self-similar analysis are reproduced and conclusions are drawn quantitatively on the gas compression by a single shock. The compression process by a sequence of shocks is discussed in self-similarity. The gas motion followed by a homogeneous isentropic compression is represented by a self-similar motion.

55504 (LA-UR—76-2670) **Microcomputer-based area control system.** Thuot, M.E.; Black, N.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 16p. (CONF-770410—3). Dep. NTIS, PC A02/MF A01.

From Microcomputer '77; Oklahoma City, Oklahoma, United States of America (USA) (6 Apr 1977).

A microprocessor control system is described, which will monitor room interlocks, enable the firing of high-voltage pulsers, and display the safety status of a 10 kJ-laser laboratory. The system will increase the safety of personnel by enforcing their exclusion from dangerous areas, by detecting breaches of security safeguards, and by disabling high-voltage power supplies. The microprocessor system allows five logical modes of operation corresponding to differing uses of areas in the laboratory; a safety procedure must be followed for each of these modes. The microprocessor follows the operator through prescribed steps of the procedure by monitoring associated door and area-interlock switches. After completion of the procedure, the microprocessor activates the corresponding enabling outputs, which permit the operator to energize high-voltage power supplies. Should safety be breached during or after completion of a procedure, e.g., should a door wrongly open, the microprocessor will cancel any enable command and will return to a safe state.

55505 Relativistic-electron-beam-induced fusion. Nakai, S.; Imasaki, K.; Yamanaka, C. (Osaka Univ. (Japan)). pp 207-215 of In Plasma physics and controlled nuclear fusion research 1976. Vol. I. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, Germany, F.R (6 - 13 Oct 1976).

The interaction of a focussed relativistic electron beam (REB) with a solid target has been investigated. The beam performance of the REB generator "REIDEN III" is 500 kV, 80 kA at a focal spot of 1.5 mm diameter, which gives $2X10^{13}Wcm^{-2}$. High-temperature dense plasmas are produced at the focal point on the solid target. It expands radially along the target surface. The measured electron temperature (1-2 keV) and the ion energy (approximately 2 keV) endorse the existence of enhanced REB absorption in a dense plasma. The neutrons observed (approximately 10^9/shot, 2.45 MeV) in the case of a CD_2 target are of thermonuclear origin and compatible with the plasma temperature. On the assumption that the electron beam of radius r is stopped at a length Λ and deposits its energy, the energy balance equation is approximately given by $\pi r^2 \Lambda n_i kT = IVtau$. On inserting beam current I, voltage V, pulse time tau and density n_i, the energy deposition distance Λ can be estimated. For a fusion temperature of 1 keV, the distance Λ must be two orders of magnitude shorter than the simple classical stopping length, which seems to be due to non-linear coupling. A pellet implosion experiment of a multi-structure target has been performed.

55506 (SAND—77-6011) **Transport of a relativistic electron beam to a thermonuclear target.** Rudakov, L.I. Jun 1977. Translated by P. Newman of USSR manuscript. 20p. Dep. NTIS, PC A02/MF A01.

Methods are described for transporting electromagnetic energy and relativistic electron beams to heat a thermonuclear target (lines with magnetic self insulation, transport through plasma, creation of a cloud of relativistic electrons about the target).

COMPONENT DEVELOPMENT AND TESTING

REFER ALSO TO CITATION(S) 54493, 55012

55507 (AI-ERDA—13201) **Helium generation in fusion reactor materials. Technical progress report, October 1976—March 1977.** Farrar, H. IV; Kneff, D.W. (Atomics International Div., Canoga Park, Calif. (USA)). 20 May 1977. Contract EY-76-C-03-0701. 35p. Dep. NTIS, PC A03/MF A01.

The immediate objectives of this program are to measure the spectrum-integrated helium generation rates and cross sections of several materials in the available high intensity neutron sources, and to develop neutron dosimetry procedures using some of these materials. This requires further development of foil activation dosimetry techniques, since the cross section measurements require a detailed characterization of each neutron environment. The neutron facilities presently used in this program include accelerators producing d-T and d-Be reactions and high flux mixed-spectrum fission reactors. Most of the work reported here has focused on neutron spectra from the d-T reaction. A description is given of the preliminary analysis of wire rings included in the irradiation capsule for helium accumulation fluence dosimetry. The results show non-uniformities in the neutron fluence distribution characterizing this irradiation, and point out the value of helium accumulation fluence dosimetry for characterizing high energy (approximately 5 to 30 MeV) neutron fields. The helium accumulation fluence data are being used to adjust the neutron fluence map for calculation of final helium generation cross sections from the other RTNS-irradiated pure element specimens. Most of the specimens irradiated in the RTNS-I experiment have been analyzed for helium, and preliminary results are presented.

55508 (CONF-770611—5) **Cryosorption pumping of helium at 4.2 K by type 5A molecular sieve.** Fisher, P.W.; Watson, J.S. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 8p. Dep. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; New York, New York, United States of America (USA) (12 Jun 1977).

Experimental results are given for helium pumping as a function of loading for three runs in the low-feed-rate pumping regime (Q less than 2×10^{-3} torr-liter/sec). Another figure shows helium pumping speeds for feed rates exceeding 2×10^{-3} torr-liter/sec. Each of these runs begins with an initial speed near 650 liters/sec. (MOW)

55509 (JAERI-M—6572) **Design of the movable limiters for JT-60.** Takashima, T.; Yamamoto, M.; Nakamura, H.; Ohkubo, Minoru; Ohta, M. (Japan Atomic Energy Research Inst., Tokyo). Jul 1976. 61p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

Two fast-acting movable rail limiters will be used in JT-60 to suppress skin effect of the plasma current with a large radius. They travel safely through a stroke of about 1 m for 0.1 sec in the build-up phase of plasma current. The movable limiter system consists of a driving mechanism, a vacuum seal, a bearing used at high temperatures in a vacuum, a molybdenum rail limiter weighing 200 kg and its auxiliary members. Many problems are involved in construction of the system because the design specifications exceed the present technology. Described are design of the movable limiter system for JT-60 and problems in the mechanical, electrical and vacuum aspects.

55510 (JAERI-M—6639) **Induced activity and dose rates in the JAERI Experimental Fusion Reactor (JXFR).** Iida, H.; Seki, Y.; Ide, T. (Japan Atomic Energy Research Inst., Tokyo). Jul 1976. 49p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Induced activity in the JAERI Experimental Fusion Reactor (JXFR) and biological dose rates around the reactor have been calculated by induced activity calculational code ACTIVE and one- and two-dimensional transport codes. The biological dose rates during reactor operation were also calculated by the one-dimensional transport code. The results of calculations are as follows. (1) The level of radioactivity in JXFR is about 10^8 Ci at shutdown after a year of operation. (2) Dose rate at outer surface of the superconducting magnet (S.C.M) shield is 1 mrem/hr a week after shutdown after a year of operation, when adequate shields are added to both sides of the S.C.M. (3) When a reactor module is extracted for repair, the dose rates are on the order of 10^6 rem/hr at surface of the first wall and 10 -- 10^5 rem/hr in the reactor room. (4) Dose rate at outer surface of the S.C.M shield is 10^3 rem/hr during reactor operation.

55511 (JAERI-M—6647) **Study of discharge cleaning in the JFT-2 tokamak with surface observation by AES.** Gomay, Y.; Tazima, T.; Fujisawa, N.; Suzuki, N.; Konoshima, S. (Japan Atomic Energy Research Inst., Tokyo). Jul 1976. 16p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Noticeable correlations were observed between the changes of discharge characteristics, wall conditions and typical mass peaks with discharge cleaning in the JFT-2 tokamak. Atomic composition of the vacuum wall surface observed by AES becomes constant with continuing discharge cleaning in the level except hydrogen and helium: 30-50% C, 20-30% Mo, 15-30% stainless steel elements and 10-15% O. The stable reproducible plasma with Z sub(eff)=4.5 was obtained in this wall condition. The limiter and vacuum wall materials (Mo and 304 stainless steel, respectively), carbon and oxygen were observed depositing on the wall in the thickness of about 300 A at the minimum inner radius of the vacuum chamber and 40 A nearly at the maximum after 2900 cleaning pulses. The mechanism determining the wall condition is also discussed.

55512 (JAERI-M—6672) **Calculation of the neutron radiation damage in D-T fusion reactor materials.** Ide, T.; Seki, Y.; Iida, H. (Japan Atomic Energy Research Inst., Tokyo). Aug 1976. 41p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

The methods of calculating the displacement damage in neutron irradiation have been studied comparatively. Effects of the secondary displacement model, treatment of nuclear reactions and nuclear data upon the neutron displacement cross sections were examined. High-energy neutrons are emitted in a fusion reactor, so it is important to calculate the displacement cross sections taking into consideration the electronic energy loss, anisotropic elastic scattering and inelastic scattering. Displacement and gas production rates in the first wall material (316 S.S.) of JAERI Experimental Reactor (JXFR) were calculated. Displacement damage rate in the superconducting magnet stabilizer (Cu) was also calculated. The displacement rate in the first wall is smaller than in the fuel cladding of a fast fission reactor but the gas production rate is larger. Electric resistance of the copper stabilizer rises significantly in the shield, indicating the need for optimum shielding.

55513 (JAERI-M—6723) **Development of a heat flux meter and measurement of the heat flux to the divertor in DIVA.** Ueda, N.; Seki, M.; Anno, K.; Kawamura, H.; Maeda, H. (Japan Atomic Energy

Research Inst., Tokyo). Oct 1976. 33p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

In evaluating the quantity of heat flowing to the divertor, the heat flux has so far been measured with a thermocouple probe of resolving time 5 ms. To examine time variation of the heat flux to the divertor, a Ni-evapolated thin film sensor of resolving time below 200 μs has been developed this time. Construction of the sensor and the results of measurements in DIVA with the conventional thermocouple and the new sensor are described.

55514 (JAERI-M—6733) **Design and characteristics of the drive mechanism for movable limiters of JT-60, (1).** Takashima, T.; Morishita, O.; Yamamoto, M.; Shimizu, M.; Ohta, M. (Japan Atomic Energy Research Inst., Tokyo). Oct 1976. 24p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

Two fast-acting movable rail limiters will be installed in a large Tokamak JT-60 being designed in JAERI. The movable limiter consists of a drive mechanism, a vacuum seal, a bearing, and a molybdenum rail limiter. Design of the drive mechanism for the movable limiter and experimental results on the driving characteristics in full scale are described.

55515 (KURRI-TR—140, pp 34-37) **Damage due to irradiation of vacuum wall materials.** Doi, K.; Shiraishi, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). 1975. (In Japanese).

From Study meeting on radiation damage of fusion reactor materials; Kumatori, Osaka, Japan (10 Sep 1974).

In Report of the study meeting on radiation damage of fusion reactor materials.

Almost all nuclear fusion reactors being devised at present adopt the construction that nuclear fusion reaction is realized by containing plasma in vacuum vessels, and the existence of the interface between solid materials and vacuum is experienced for the first time. This poses problems in the materials for nuclear fusion reactors, and the properties of solid surface are newly required in addition to those of the materials for nuclear fission reactors. The environment of the interface in a toroidal type D-T reactor in steady operation is as follows: surface temperature 800 - 1000 degree K, incident neutron flux 10^{18} n/square cm sec, surface load 1000 W/square cm. In this environment, spattering, blistering, self spattering, secondary electron emission, the desorption of adsorbed gas, and surface temperature rise occur mutually competitively or suppressively, consequently the damage of surface due to irradiation becomes very complex. Recently, the experiments on the blistering on molybdenum surface and the change of material to amorphism on the vacuum vessel surface of JFT-2 have been carried out, and the results are reported in this paper. It is concluded that separation occurs when the inactive gas atoms of approximately same number as metallic atoms are injected near the surface of metals. Amorphous state can be formed by special treatment from the substances obtainable only in crystalline state.

55516 (KURRI-TR—140, pp 27-33) **Materials required for nuclear fusion reactors and problems in their development research.** Watanabe, R.i (National Research Inst. for Metals, Tokyo (Japan)). 1975. (In Japanese).

From Study meeting on radiation damage of fusion reactor materials; Kumatori, Osaka, Japan (10 Sep 1974).

In Report of the study meeting on radiation damage of fusion reactor materials.

As an early realizable nuclear fusion reactor type, the D-T reactor utilizing the nuclear fusion of deuterium and tritium is considered, and various reactor types are proposed and investigated. The Tokamak type nuclear fusion reactor has been studied relatively frequently, and its conceptual design has been carried out recently. The reactor comprises plasma core, blanket, and superconductive magnet. The blanket has the functions as plasma-containing vessel, tritium producer, the convertor of neutron energy to heat, and radiation and thermal shield, therefore the materials used are those for construction tritium production cooling, moderating, shielding, and neutron multiplying. The core plasma containment in the Tokamak type reactor is carried out with the superconductive magnet, and the magnet is composed of coil material, superconductive coil stabilizer, coolant, thermal and electric insulators, and structural material. In the first wall, considerably high temperature is expected, and large load is applied due to irradiation. Its one side faces to vacuum, and the other side is cooled with coolant. Nuclear, physical, chemical and mechanical properties, surface effect, formability, and irradiation effect are required for the material. The candidate materials are Fe-base and Ni-base alloys and high melting point metals such as V. Nb and Mo, but the determination requires the accumulation of much more data.

55517 (KURRI-TR—140, pp 17-26) **Nuclear reaction in a fusion reactor.** Kimura, I. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). 1975. (In Japanese).

From Study meeting on radiation damage of fusion reactor materials; Kumatori, Osaka, Japan (10 Sep 1974).

In Report of the study meeting on radiation damage of fusion reactor materials.

The problems associated with the nuclear reactions in a fusion reactor are discussed. The reactions considered are D-T, D-D, and D-3-He reactions. The most promising reactor is a D-T reactor. The data concerning neutron-induced reactions are required from the view points of tritium breeding, heat generation and irradiation effect. The Li-n reactions are important for tritium breeding. The accuracy of the cross-section measurement of the reactions has some effect on the breeding ratio, and the precise measurement is requested. The (n, 2n) reaction with the vacuum wall material and blanket of a fusion reactor contributes on the tritium breeding. The neutron gain with the (n, 2n) reaction in Steiner blanket is 0.075+-7%. The important causes of heat generation are nuclear reaction and gamma-ray. For the evaluation of these causes, the distribution of heat sources is necessary. The data concerning the distribution are scarce, and the measurement is required hereafter. The results of calculation by Steiner on the heat generating rate showed that the rate was large at the vacuum wall, and the difference was seen between the designs of reactors with Li coolant and with coolant of flibe. The radiation effects on materials by neutrons are due to atomic displacement, nuclear transformation, and hydrogen and helium production. It is necessary to measure the reaction cross-section concerned. However, the measurement of the neutron energy between a few MeV and 14 MeV is hard because of the lack of neutron source. The estimation by calculation is in progress.

55518 (ORNL—5275, pp 251-272) **Fusion reactor technology program.** Steiner, D.; Alsmiller, R.G. Jr.; Appleton, B.R. Jun 1977.

In Fusion Energy Division annual progress report for period ending December 31, 1976.

Summaries are given of research progress for each of the following areas: (1) materials compatibility studies, (2) mechanical properties of structural materials, (3) neutronics, (4) radiation effects, (5) surface studies, (6) systems studies, and (7) tritium behavior. (MOW)

55519 (ORNL/TM—5956) **Calculated irradiation response of materials using a fusion-reactor first-wall neutron spectrum.** Gabriel, T.A.; Bishop, B.L.; Wiffen, F.W. (Oak Ridge National Lab., Tenn. (USA)). Jun 1977. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

This paper presents the calculated irradiation response in displacements per atom and gas production values of a number of elements and metal alloys in a fusion reactor first-wall neutron spectrum. The gas production rates for new alloy compositions can be synthesized from these results, and all comparisons are thus kept on a consistent basis. The sensitivity to the nuclear data base used and to the exact neutron spectrum is found to be greatest in the helium production rates. This helium production value in some alloys may also be sensitive to composition. In type 316 stainless steel variations of +-9 percent are possible for compositions within the specification range.

55520 **Vacuum vessel and pumping system of the JET experiment.** Eckhartt, D. (Culham Lab., Abingdon, Eng.). pp 33-39 of In Ninth symposium on fusion technology. Oxford; Pergamon Press (1976).

The vacuum vessel of the J.E.T. (Joint European Torus) experiment has been designed as an all-metal and completely welded composite torus with a non-circular cross section. It consists of thirty-two wedge shaped sectors which take up the external forces, linked together by cylindrical bellows sctions which provide for the required electrical resistance in longitudinal direction (i.e. parallel to the induced plasma current). Rigid sectors and bellows sections have a "double-wall" structure, the interspace between the walls is used to control the temperature of the vacuum vessel by circulating hot or cold gas. The present state of the design work, related tests, and the manufacture of prototypes is described. Pumping the vacuum vessel will be done by cryo-pumps and turbomolecular pumps, backed by roughing pumps. The feasibility of this scheme has been studied recently by European industries competent in the field of cryo-pumping and cryogenic surroundings.

55521 **Light—plasma interaction studies with high-power glass lasers.** Manes, K.R.; Ahlstrom, H.G.; Haas, R.A.; Holzrichter, J.F. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Opt. Soc. Am.;* 67: No. 6, 717-726(Jun 1977).

High-intensity (10^{13}—10^{17} W/cm^2) 1.06 μm laser light absorption experiments with spherical and planar targets suggest that inverse bremsstrahlung absorption is not the dominant absorption mechanism. Evidence is presented that resonance absorption together with ponderomotive force effects such as filamentation and density profile steepening strongly influence the laser light absorption.

55522 **Integral experiments for testiag nuclear data for fusion reactors.** Profio, A.E. (Univ. of California, Santa Barbara). *Trans. Am. Nucl. Soc.;* 26: 486-487(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55523 Calculation of 15-MeV neutron-induced charged-particle spectra on stainless steel Type 316. Arthur, E.D.; Young, P.G. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **26**: 503(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

55524 Tokamak divertor slot design to enhance magnet shielding. Gohar, Y.; Maynard, C.W. (Univ. of Wisconsin, Madison). *Trans. Am. Nucl. Soc.;* **26**: 508-509(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

GENERAL AND MISCELLANEOUS

MANAGEMENT

55525 (ERDA—77-41/6) **ERDA headquarters reports: June 1977.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Administrative Services). Jun 1977. 12p. Dep. NTIS, PC A02/MF A01.

This abridged version of ERDA Headquarters Reports contains a list of new ERDA Headquarters reports and a partial list of previous ERDA Headquarters reports. A complete issue will again be published in July, 1977; the previous one was in May. (RWR)

55526 (UCRL—52000-77-4) **Energy and technology review.** Selden, R.W. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1977. Contract W-7405-ENG-48. 34p. Dep. NTIS, PC A03/MF A01.

A separate abstract was prepared for each of the three items in this issue. (RWR)

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 53866, 53867, 53868, 53915, 54000, 55318, 55324

55527 (ANL—77-28) **Comparison of the IBM 370/168 MODEL 3 with the Amdahl 470V/6 and the IBM 370/195 using benchmarks.** Snider, D.R.; Midlock, J.L.; Hinds, A.R. (Argonne National Lab., Ill. (USA)). Apr 1977. Contract W-31-109-ENG-38. 266p. Dep. NTIS, PC A12/MF A01.

As part of the studies preliminary to the acquisition of additional computing capability at Argonne National Laboratory, six groups of jobs were run on the IBM 370/195 at the Applied Mathematics Division of Argonne National Laboratory, on an Amdahl 470V/6 at the Amdahl manufacturing facilities in Sunnyvale, California, and on an IBM 370/168 MODEL 3 at the IBM Field Support Center in Gaithersburg, Maryland. This report compares the performance of the IBM 370/168 MOD 3 with that of the other two machines. Differences in machine configurations were minimized. The memory size of each machine was identical, the I/O configurations were as similar as possible, and the same versions of OS/MVT 21.7 and ASP 3.1 were used on all three machines. This allowed the comparison to be based on the relative performance of the three CPUs. 15 figures, 24 tables.

55528 (ANL—77-49) **Updating the symmetric indefinite factorization with applications in a modified Newton's method.** Sorensen, D.C. (Argonne National Lab., Ill. (USA)). Jun 1977. Contract W-31-109-ENG-38. 156p. Dep. NTIS, PC A08/MF A01.

Thesis.

In recent years the use of quasi-Newton methods in optimization algorithms has inspired much of the research in an area of numerical linear algebra called updating matrix factorizations. Previous research in this area has been concerned with updating the factorization of a symmetric positive definite matrix. Here, a numerical algorithm is presented for updating the Symmetric Indefinite Factorization of Bunch and Parlett. The algorithm requires only $O(n^2)$ arithmetic operations to update the factorization of an n x n symmetric matrix when modified by a rank-one matrix. An error analysis of this algorithm is given. Computational results are presented that investigate the timing and accuracy of this algorithm. Another algorithm is presented for the unconstrained minimization of a nonlinear functional. The algorithm is a modification of Newton's method. At points where the Hessian is indefinite the search for the next iterate is conducted along a quadratic curve in the plane spanned by a direction of negative curvature and a gradient-related descent direction. The stopping criteria for this search take into account the second-order derivative information. The result is that the iterates are shown to converge globally to a critical point at which the Hessian is positive semidefinite. Computational results are presented which indicate that the method is promising. 6 figures, 9 tables.

55529 (ANL—77-XX-73) **Updating the Symmetric Indefinite Factorization with applications in a modified Newton's method.** Sorensen, D.C. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 155p. Dep. NTIS, PC A08/MF A01.

Thesis.

In recent years the use of quasi-Newton methods in optimization algorithms has inspired much of the research in an area of numerical linear algebra called updating matrix factorizations. Previous research in this area has been concerned with updating the factorization of a symmetric positive definite matrix. Here, a numerical algorithm is presented for updating the Symmetric Indefinite Factorization of Bunch and Parlett. The algorithm requires only $O(n^2)$ arithmetic operations to update the factorization of a symmetric matrix when modified by a rank-one matrix. An error analysis of this algorithm is given. Computational results are presented that investigate the timing and accuracy of this algorithm. Another algorithm is presented for the unconstrained minimization of a nonlinear functional. The algorithm is a modification of Newton's method. At points where the Hessian is indefinite the search for the next iterate is conducted along a quadratic curve in the plane spanned by a direction of negative curvature and a gradient related descent direction. The stopping criteria for this search takes into account the second-order derivative information. The result is that the iterates are shown to converge globally to a critical point at which the Hessian is positively semidefinite. Computational results are presented which indicate that the method is promising. 4 figures, 9 tables.

55530 (ORNL/CSD/TM—9/R1) **User's guide for ICE-II.** Fraley, S.K. (Oak Ridge National Lab., Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A03/MF A01.

ICE-II is a cross-section mixing code which will accept cross sections from an AMPX working library and produce mixed cross sections in the AMPX working library format, ANISN format, the group-independent ANISN format, and the Monte Carlo processed cross section library format. User input is in the free-form or fixed-form FIDO structure. The code is operable as a module in the AMPX system.

55531 (ORNL/CSD/TM—22) **GRAFAR: a computer code for graphic display of input data to the FAR2D/FAROUT code.** Thomas, B.; Bledsoe, J.L.; Holdeman, J.T. (Oak Ridge National Lab., Tenn. (USA)). [nd]. Contract W-7405-ENG-26. 150p. Dep. NTIS, PC A08/MF A01.

A graphical display code (GRAFAR) was developed at ORNL as a part of the Unified Transport Approach task. This code, which was funded by the Nuclear Regulatory Commission, will be used in the visual representation of shoreline geometries, velocity flow conditions, bathymetric contours, and isotherms in coastal regions or inland waterways surrounding power plant sites. The developers of GRAFAR intend that it be used in the correction and adjustment of input data to the tidal-transient, two-dimensional far-field thermal model FAR2D, which was developed under the direction of A.H. Eraslan of the University of Tennessee. 12 figures, 3 tables.

55532 (SAND—77-1052) **User/programmer guide for UCMD 82: compaction of drawing dictionary.** Robbins, D.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 20p. Dep. NTIS, PC A02/MF A01.

This document describes program UCMD 82, an Applicon AGS/870 User Command for compacting a drawing dictionary. Input is from a drawing on the table. Output is a compacted dictionary on the table and a summary of the before and after sector dictionary map.

55533 (SAND—77-1053) **User/programmer guide for UCMD 83: extraction of a macro from a file drawing and appending it to a drawing on the table.** Robbins, D.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jul 1977. Contract EY-76-C-04-0789. 23p. Dep. NTIS, PC A02/MF A01.

This document describes program UCMD 83, an Applicon AGS/870 User Command for extracting a macro from a file drawing and appending it to a drawing on the table.

55534 (SAND—77-8232) **PARAM: a FORTRAN preprocessor for variable dimensioning.** Jefferson, T.H. (Sandia Labs., Livermore, Calif. (USA)). Jun 1977. Contract EY-76-C-04-0789. 23p. Dep. NTIS, PC A02/MF A01.

PARAM is a FORTRAN preprocessor which allows one to adjust easily the size of his program according to the size problem to be solved. The preprocessor scans the source code and makes appropriate integer substitutions as indicated on source cards with "P" in column 1. These variable parameters may appear in dimension-specifying statements, such as DIMENSION, COMMON, REAL, and DOUBLE, as well as in arithmetic statements and elsewhere throughout the source code.

55535 (TREE—1138) **MOCARS: a Monte Carlo code for determining the distribution and simulation limits.** Matthews, S.D. (EG and G Idaho, Inc., Idaho Falls (USA)). Jul 1977. Contract EY-76-C-07-1570. 112p. Dep. NTIS, PC A06/MF A01.

MOCARS is a computer program designed for the INEL CDC 76-173 operating system to determine the distribution and simulation limits for a function by Monte Carlo techniques. The code randomly samples data from any of the 12 user-specified distributions and then either evaluates the cut set system unavailability or a user-specified function with the sample data. After the data are ordered, the values at various quantities and associated confidence bounds are calculated for output. Also available for output on microfilm are the frequency and cumulative distribution histograms from the sample data. 29 figures, 4 tables.

55536 (UCID—16996(Rev.1)) **Basic manual for the use of automatically programmed tools.** Zimmerman, B.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1977. Contract W-7405-ENG-48. 74p. Dep. NTIS, PC A04/MF A01.

The purpose of this manual is to supplement the lectures of a course in basic APT usage. This course is given to many machine shop personnel at LLL in order to acquaint them with basic numerical control and programming language use.

55537 (UCID—30059(Rev.2)) **GEARB: solution of ordinary differential equations having banded Jacobian.** Hindmarsh, A.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1977. Contract W-7405-ENG-48. 39p. Dep. NTIS, PC A03/MF A01.

GEARB is a package of subroutines for the numerical solution of systems of ordinary differential equations in which the Jacobian matrix has a band structure. It is a modified version of the package described in GEAR: Ordinary Differential Equation System Solver, UCID-30001 (Rev. 3), and is intended primarily for stiff problems. The principal modification is the substitution of band matrix solution routines for the full matrix solution routines. This report describes the GEARB package briefly and gives instructions on its use.

55538 (UCID—30156) **PICTURE: a picture-drawing language for the TRIX/RED report editor.** Beatty, J.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Apr 1977. Contract W-7405-ENG-48. 77p. Dep. NTIS, PC A05/MF A01.

Picture is a set of commands for drawing diagrams that are to be plotted by REDPP. Picture commands may be included in TRIX/RED source files or may be separately compiled and displayed by REDPP. The Picture/REDPP system is also useful for constructing slides, viewgraphs, and movie titles. The program PCOMP (which translates Picture statements into REDPP commands), the TRIX/RED report editor, and the RED postprocessor REDPP are all available in public files as part of the Livermore time-sharing system.

55539 (UCLA—34P214-32) **Device independent graphics through table driven translation.** Switzky, C.M. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). Jun 1976. Contract EY-76-S-03-0034-214. 104p. (UCLA-ENG—7655). Dep. NTIS, PC A03/MF A01.

Thesis.

The goal of device-independent computer graphics is to allow the programmer to write programs capable of running on a variety of machines. Given a device-independent language, the problem becomes one of converting the device-independent information to a suitable representation for controlling a specific device. One approach to this problem is a separate translation routine for each graphics device. Because the basic principles of operation of most graphics devices are similar, this approach requires repeated code in each routine, and a separate new coding for a new device. To avoid this, a generalized table driven translation is described. Individual table elements represent basic functions which allow mapping to different machine characteristics. To change devices then becomes a simple matter of loading different table entries. Tables are capable of describing the characteristics of devices such as Imlac, IBM 2250, Calcomp, Tektronix, Computek, Conographics, and others. 9 figures.

55540 (UCLA—34P214-38) **Modeling for synthesis: the gap between intent and behavior.** Estrin, G. (California Univ., Los Angeles (USA). Dept. of Computer Science). 1977. Contract EY-76-S-03-0034-214. 7p. (CONF-770211—6). Computer Society, Long Beach, CA.

From ACM/IEEE symposium on design automation and microprocessors; Palo Alto, California, United States of America (USA) (24 Feb 1977).

The difficulties inherent in the design of needed microprocessors are noted. Efforts were directed toward the synthesis of complex systems which allow deeper analysis. A methodology for the design of software or hardware systems emerged; in support of that methodology the set of tools embodied in the System ARchitects Apprentice (SARA) system was designed and implemented. This paper presents the highlights of the synthesis methodology, the set of primitives (structural and behavioral) used by modeling tools in SARA, and a quick look at the design procedure proposed to support the methodology. 1 figure, 41 references. (RWR)

55541 (UCRL—79316) **Operator splitting on vector processors.** Dubois, P.F.; Rodrigue, G.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1977. Contract W-7405-ENG-48. 4p. (CONF-770619—1). Dep. NTIS, PC A02/MF A01.

From International symposium on computer methods for partial differential equations; Bethlehem, Pennsylvania, United States of America (USA) (22 Jun 1977).

The basic idea behind operator splitting for two-dimensional time-dependent parabolic partial differential equations is to break the problem down to that of solving two one-dimensional problems. If one uses a vectorized Gauss elimination to solve these 1D problems, then one is faced with transposing several matrices in between the two solution processes. Parallel Gauss elimination is compared with cyclic reduction, which requires no transposes. Actual STAR timings differ markedly from theoretical ones. 2 tables.

55542 (UCRL—79328(Pt.2)) **ELIPTI-TORMAC: a code for the solution of general nonlinear elliptic problems over 2-D regions of arbitrary shape.** Taylor, J.C.; Taylor, J.V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Apr 1977. Contract W-7405-ENG-48. 9p. (CONF-770619—2). Dep. NTIS, PC A02/MF A01.

From International symposium on computer methods for partial differential equations; Bethlehem, Pennsylvania, United States of America (USA) (22 Jun 1977).

A code (ELIPTI) designed to solve nonlinear elliptic equations over regions of arbitrary shape is discussed. The numerical method is well-known ADI method. The code aims at robustness and ease of implementation consistent with acceptable accuracy and rapidity of convergence. Results of its use are presented in a large set of problems in memory of which comparisons against analytical solutions were possible. 4 figures, 3 tables.

55543 **Two-dimensional spectral factorization with applications in recursive digital filtering.** Ekstrom, M.P.; Woods, J.W. (Lawrence Livermore Lab., CA). *IEEE Trans. Acoust., Speech, Signal Process.;* **ASSP-24**: No. 2, 115-128(Apr 1976).

The concept of spectral factorization is extended to two dimensions in such a way as to preserve the analytic characteristics of the factors. The factorization makes use of a homomorphic transform procedure due to Wiener. The resulting factors are shown to be recursively computable and stable in agreement with one-dimensional (1-D) spectral factorization. The factors are not generally two-dimensional (2-D) polynomials, but can be approximated as such. These results are applied to 2-D recursive filtering, filter design, and a computationally attractive stability test for recursive filters. 11 figures.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 55255, 55315, 55333, 55340

55544 **Role of data centers in technical information transfer.** Lide, D.R. Jr. (National Bureau of Standards, Washington, DC). *Trans. Am. Nucl. Soc.;* **26**: 563(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

CIVILIAN DEFENSE

55545 **Effectiveness of soil as shielding for expedient fallout shelters.** Beer, M.; Cohen, M.O. (Mathematical Applications Group, Inc., Elmsford, NY). *Trans. Am. Nucl. Soc.;* **26**: 494-496(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

CIVILIAN DEFENSE

55545 Effectiveness of soil as shielding for expedient fallout shelters. Beer, M.; Cohen, M.O. (Mathematical Applications Group, Inc., Elmsford, NY). *Trans. Am. Nucl. Soc.;* 26: 494-496(Jun 1977).

From Transactions of the American Nuclear Society 1977 annual meeting; New York, NY, USA (12 Jun 1977).

CORPORATE INDEX

In the corporate index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

A

Acurex Corp., Mountain View, Calif. (USA). Aerotherm Div.
Evaluation of molten scrubbing for fine particulate control. Final report Dec 75—Feb 76, 2:54240 (PB—266092)
Aerochem Research Labs., Inc., Princeton, N.J. (USA)
Synthesis of silane and silicon in a nonequilibrium plasma jet. Third quarterly report, December 21, 1976—March 20, 1977. (AeroChem(TN)—17), 2:54099 (ERDA/JPL/954560—77/1)
Aerojet Nuclear Co., Idaho Falls, Idaho (USA)
Flow rate calculations for LOFT core support barrel outlet nozzle: reactor vessel outlet nozzle, 2:54523 (TID—27665)
LOCE core differential pressures, 2:54522 (TID—27664)
Aeronautical Research Associates of Princeton, Inc., N.J. (USA)
Modeling of turbulent mixing and reactions in chemical lasers. Final report 1 Oct 74—30 Nov 76, 2:54971 (AD-A—039010)
Aerospace Corp., El Segundo, Calif. (USA). Ivan A. Getting Labs.
Space power systems-what will be their impact on the upper atmosphere and ionosphere. Technical report, 2:55064 (AD-A—038924)
Aerospace Corp., Los Angeles, Calif. (USA)
Heterogeneous reactions of nitrogen oxides in simulated atmospheres. Interim report Nov 73—Nov 76, 2:55075 (PB—266127)
Laboratory measurement of sulfur dioxide deposition velocities. Interim report Nov 73—Nov 76, 2:55076 (PB—266137)
Air Force Aero-Propulsion Lab., Wright-Patterson AFB, Ohio (USA)
The effect of turbulence on laser beam quality. Final report Mar 73—Aug 76, 2:54968 (AD-A—038667)
Air Force Geophysics Lab., Hanscom AFB, Mass. (USA)
Polarization spectra of centimeter wavelength solar bursts using whole-Sun observations. Environmental research paper, 2:55219 (AD-A—038782)
Air Force Inst. of Tech., Wright-Patterson AFB, Ohio (USA). School of Engineering
Isotopic analysis of low-activity plutonium samples using high-resolution alpha and photon spectroscopy, 2:54878 (AD-A—038910)
Nuclear aircraft feasibility study (executive summary). Report for 1 Mar 74—7 Feb 75, 2:54562 (AD-B—008941)
Air Force Weapons Lab., Kirtland AFB, N.Mex. (USA)
A report on the status of linear collective ion acceleration with intense relativistic electron beams. Final report, 2:55020 (AD-A—038737)
A study of silicon oxide growth mechanisms for the purpose of identifying hardness assurance total dose screens. Final report, 2:54850 (AD-A—038639)
STREAM: a three-dimensional Monte Carlo ray-tracing code in cylindrical geometry. Final report, 2:55499 (AD-A—038555)
American Association for Comprehensive Health Planning, Alexandria, Va.
Ct scanning, 2:55127 (HRP—0015521)
American Electroplaters' Society, East Orange, N.J.
Treatment of electroplating wastes by reverse osmosis. Final report, 2:54744 (PB—265393)
Ames Lab., Iowa (USA)
Design of the Broers type LaB_6 gun, 2:55044 (IS-M—90)
Generation of self-consistent Gibbs energy functions for binary systems: the Fe—Cu system as an example, 2:54808 (IS-M—91)
Problem of obtaining optimum brightness from your LaB_6 gun, 2:54079 (IS-M—89)
AN SSSR, Moscow. Inst. Vysokikh Temperatur
System for measuring the local electrical conductivity of plasma, 2:54717 (ERDA-tr—295)
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Study on spatial distribution of plasma oscillation intensity in the induced electrodeless discharge, 2:55440 (KFTI—76-24)
Argonne National Lab., Ill. (USA)
Acoustic emission from fuel pellets in a simulated reactor environment, 2:54498 (CONF-761233—1)
Boiling and two-phase flow problems in liquid metal fast breeder reactor safety analysis, 2:54578 (CONF-761039—2)
Comparison of the IBM 370/168 MODEL 3 with the Amdahl 470V/6 and the IBM 370/195 using benchmarks, 2:55527 (ANL—77-28)
Gas release from surfaces under x-ray impact: photodesorption, photocatalysis, 2:54829 (CONF-750839—3)
Grundy County demonstration site: phase II. Progress report, 1976—1977, 2:53704 (ANL-K—77-3087-2)
Integrated mined-area reclamation and land use planning. Volume 3A. A case study of surface mining and reclamation planning: South Boulder Creek Park Project, Sand and Gravel Operations, Boulder, Colorado, 2:55094 (ANL/EMR—1(Vol.3a))
Light-water-reactor safety research program. Quarterly progress report, October—December 1976, 2:54568 (ANL—77-10)
Model for the induction of bone cancer by ^{224}Ra, 2:55165 (CONF-760992—17)
Survey of electric utility demand for western coal, 2:53819 (ANL/SPG—1)
Tungsten cladding of W-UO_2 nuclear-rocket fuel subsections by vapor deposition, 2:54832 (ANL—7235)
Updating the symmetric indefinite factorization with applications in a modified Newton's method, 2:55528 (ANL—77-49)
Updating the Symmetric Indefinite Factorization with applications in a modified Newton's method, 2:55529 (ANL—77-XX-73)
Arizona State Univ., Tempe (USA). Coll. of Engineering and Applied Sciences
Progress report, May 1977, 2:54087 (COO—2982-15)
Arizona Univ., Tucson (USA). Dept. of Soils, Water and Engineering
Feasibility of solar energy for feedlot operation and irrigation pumping. Final report 1 May 75-31 Dec 76, 2:54112 (PB—265651)

Arizona Univ., Tucson (USA). Optical Sciences Center
Unstable resonator theory. Final report, 2:54970 (AD-A—038820)
Army Materials and Mechanics Research Center, Watertown, Mass. (USA)
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Warm-die-forming of beta titanium alloy strip. Final report, 2:54773 (AD-A—038848)
Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee
Diagnostics used at TFR Tokamak, 2:55375 (EUR-CEA-FC—877)
Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee
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Feasibility study on the impact of agencies and codes on university and college energy use. Volume II. Source data, 2:54677 (TID—27629-P1P2)
Atomic Industrial Forum, Washington, D.C. (USA)
A guide to information resources for nuclear environmental reporting. Directory report, 1973-76, 2:54669 (PB—265318)
Atomics International Div., Canoga Park, Calif. (USA)
Deuterium tracer method for investigating the chemistry of coal liquefaction. Quarterly technical progress report, June—September 1976, 2:53652 (FE—2328-4)
Helium generation in fusion reactor materials. Technical progress report, October 1976—March 1977, 2:55507 (AI-ERDA—13201)
Auburn Univ., Ala. (USA). Engineering Extension Service
Measuring and improving the efficiency of boilers. A manual for determining energy conservation in steam generating power plants. Final report, 2:54741 (PB—265713)
Avco-Everett Research Lab., Everett, Mass. (USA)
High power density MHD generators. Final technical report, 2:54711 (AD-A—038612)
MHD power generation (Viking series) with hydrocarbon fuels. Final technical report 7 Apr—15 Aug 75, 2:54715 (AD-A—038599)

B

Battelle Columbus Labs., Ohio (USA)
Agglomerating burner gasification process: design, installation, and operation of a 25-ton-a-day process development unit. Monthly progress report for May 1977, 2:53617 (FE—1513-60)
Steam—water mixing and system hydrodynamics program. Task 4. Quarterly progress report, January 1, 1977—March 31, 1977, 2:54569 (BMI-NUREG—1972)
Battelle Pacific Northwest Labs., Richland, Wash. (USA)
Avoidance of thermal effluent by juvenile chinook salmon (Oncorhynchus tshowytscha) and its implications in waste heat management, 2:55106 (BNWL-SA—6222)
Core thermal model: COBRA-IV development and applications, 2:54570 (BNWL—2212)
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GAPCON-3: a computer code to analyze the path-dependent thermal and mechanical performance of nuclear fuel rods, 2:54285 (BNWL-SA—5962)
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Pollutant transformation and removal measurements at Metromex, 2:55060 (BNWL-SA—6085)
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Verification of fuel centerline thermocouple readings through response to linear power decreases, 2:54284 (BNWL—2189)
BDM Corp., Albuquerque, N.Mex. (USA)
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Bendix Corp., Denver, Colo. (USA). Energy, Environment, and Technolgy Office
Feasibility of automatically steering low coal shuttle car. Volume II. Final research report 1976, 2:53731 (PB—265179)
Test program for automatic steering shuttle car. Final research report 1976, 2:53730 (PB—265178)
Bendix Corp., Kansas City, Mo. (USA)
Synthesis of polyaminobismalemide, 2:54915 (BDX—613-1480(Rev.))
Big Chief Roofing Co., Ardmore, Okla (USA)
Water reuse in a paper reprocessing plant. Final report, 2:54750 (PB—265232)
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SUBJECT DESCRIPTOR;QUALIFIER
Title, (supplementary information), citation number, (report number)

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

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77/7	2:53923	Dep. NTIS, PC A03/MF A01
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77/1	2:53845	Dep. NTIS, PC A08/MF A01
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8720	2:53736	*See* PB-265617
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8192	2:53825	*See* PB-265931
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22258	2:55042	Dep. NTIS, PC A02/MF A01
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22363	2:55110	Dep. NTIS, PC A02/MF A01
22435	2:54781	Dep. NTIS, PC A02/MF A01
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2123	2:54217	Dep. NTIS, PC A09/MF A01
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226	2:54807	Dep. NTIS, $3.50
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3733	2:55362	Dep. NTIS (US Sales Only), PC A02/MF A01
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138(Suppl.2)	2:54571	Combustion Engineering, Inc., Windsor, CT
CONF-730912-		(International conference on physical metallurgy of reactor fuel elements, Berkeley, England, UK, 2-7 Sep 1973)
	2:54500	24.00 pou
CONF-750306-		(15. annual ASME symposium, Albuquerque, New Mexico, USA, 6-7 Mar 1975)
	2:53606	American Society of Mechanical Engineers (1975). $10.00
CONF-750388-		(Conference on the effects of cyclotron emission on the power balance in fusion systems, Palo Alto, California, United States of America (USA), 3-4 Mar 1975)
	2:55365	*See* EPRI-SR-16
CONF-7504134-		(9. seminar on the methods of determination and on significance of trace elements in biological materials, Prague, Czechoslovakia, 15 Apr 1975)
	2:54874	*See* INIS-mf-3590
CONF-7505139-		(Coal agglomeration and conversion symposium, Morgantown, West Virginia, United States of America (USA), 5-6 May 1975)
	2:53666	West Virginia Geological and Economic Survey, Morgantown, WV
CONF-750641-		(IAEA international symposium on the Oklo phenomenon, Libreville, Gabon, 23-27 Jun 1975)
7	2:53996	*See* LA-tr-77-40
CONF-750712-		(Annual meeting of the International Solar Energy Society, Los Angeles, California, USA, 28 Jul-1 Aug 1975)
21	2:54126	*See* LBL-4436
CONF-750839-		(Symposium on radiation effects on solid surfaces, Chicago, Illinois, USA, 25-26 Aug 1975)
3	2:54829	Dep. NTIS, $4.00
CONF-760398-		(WESTEC 1976, Los Angeles, California, United States of America (USA), 8-11 Mar 1976)
1	2:54796	*See* LBL-4920
CONF-7603103-		(2. coal conference, New Orleans, Louisiana, United States of America (USA), 10 Mar 1976)
1	2:53727	Continental Illinois National Bank and Trust Co., Chicago, IL
CONF-7604134-		(Seminar on mineral development on Indian lands, Tucson, Arizona, United States of America (USA), 1-2 Apr 1976)
	2:54658	Rocky Mountain Mineral Law Foundation (1976).
CONF-7604138-		(American Mining Congress 1976 Financial Conference, Phoenix, Arizona, United States of America (USA), 9 Apr 1976)
1	2:53820	Continental Illinois National Bank and Trust Co., Chicago, IL
CONF-760564-		(The wave and salinity gradient energy conversion workshop proceedings, Newark, Delaware, USA, 24-26 May 1976)
	2:54202	*See* COO-2946-1
CONF-7605143-		(9. world mining congress, Dusseldorf, German, Federal Republic of (F.R. Germany), May 1976)
	2:53748	Verlag Glueckauf GmbH (1976).
CONF-7605155-		(Alaska Bankers Association Convention, Anchorage, Alaska, United States of America (USA), 10 May 1976)
1	2:54681	Continental Illinois National Bank and Trust Company of Chicago (1976).
CONF-7606121-		(Seminar on the use of heat pumps in industry for heat recovery, Essen, German, Federal Republic of (F.R. Germany), 29 Jun-1 Jul 1976)
1	2:54728	*See* AED-Conf-76-262-001
2	2:54729	*See* AED-Conf-76-285-001
CONF-760804-		(4. international conference on strength of metals and alloys, Nancy, France, 30 Aug-3 Sep 1976)
9	2:54782	*See* LBL-5401
CONF-760822-		(14. US ERDA air cleaning conference, Sun Valley, Idaho, United States of America (USA), 2-4 Aug 1976)
P1	2:54031	Dep. NTIS, PC A24/MF A01
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CONF-7608100-		(International symposium of analytical chemistry in the exploration, mining and processing of materials, Johannesburg, South Africa, 23-27 Aug 1976)
1	2:53679	*See* IS-ICP-39
CONF-760958-		(3. international symposium of plasma physics on heating in torodial devices, Varenna, Italy, 6-17 Sep 1976)
	2:55362	*See* CEA-CONF-3733
CONF-760992-		(2. international symposium on biological effects of Ra-224, Neuherberg/Muenchen, German, Federal Republic of (F.R. Germany), 20 Sep 1976)
17	2:55165	Dep. NTIS, PC A02/MF A01
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5	2:54285	*See* BNWL-SA-5962
CONF-7609129-		(Symposium on new concepts in fault current limiters and power circuit breakers, Buffalo, New York, United States of America (USA), 28-30 Sep 1969)
	2:54242	*See* EPRI-EL-276-SR
CONF-7609136-		(Workshop on institutional alternatives for breeder reactor development and commercialization, McLean, Virginia, United States of America (USA), 8-9 Sep 1976)
1	2:54269	*See* P-5715
CONF-7609150-		(IAEA international training course on nuclear power project planning and implementation, Karlsruhe, F.R. Germany, 6 Sep 1976)
11	2:54476	*See* AED-Conf-76-660-027
CONF-761012-		(6. international conference on plasma physics and controlled nuclear fusion research, Berchtesgaden, German, Federal Republic of (F.R. Germany), 6-13 Oct 1976)
84	2:55361	*See* AED-Conf-76-506-013
CONF-761039-		(Two-phase flow and heat transfer symposium, Fort Lauderdale, Florida, United States of America (USA), 18-20 Oct 1976)
2	2:54578	Dep. NTIS, PC A02/MF A01

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CONF-761091-		(Consumer conference on solar energy development, Albuquerque, New Mexico, United States of America (USA), 2-5 Oct 1976)
1	2:54125	*See* LA-UR-76-2094
CONF-761129-		(Terrestrial PV measurements workshop, Baton Rouge, Louisiana, United States of America (USA), 10-12 Nov 1976)
4	2:54100	*See* ERDA/NASA/1022-76/2
5	2:54101	*See* ERDA/NASA/1022-76/3
CONF-761174-		(Conference on sulfur oxides, Cleveland, Ohio, United States of America (USA), 19 Nov 1976)
1	2:55185	*See* COO-2874-13
CONF-761223-		(International workshop on climate and solar energy conversion, Schloss Laxenburg, Austria, 8-10 Dec 1976)
1	2:54096	*See* UCRL-78855
CONF-761232-		(National congress on plasma physics, Paris, France, 6 Dec 1976)
2	2:55375	*See* EUR-CEA-FC-877
CONF-761233-		(Acoustic emission meeting, London, United Kingdom of Great Britain and Northern Ireland (UK), 20-21 Dec 1976)
1	2:54498	Dep. NTIS, PC A02/MF A01
CONF-770113-		(4. meeting of the centers for the analysis of thermal/mechanical energy conversion concepts, Berkeley, California, United States of America (USA), 24-25 Jan 1977)
	2:54163	*See* COO-4051-4
CONF-770116-		(Workshop on application of phase diagrams in metallurgy and ceramics, Gaithersburg, Maryland, United States of America (USA), 10-12 Jan 1977)
3	2:54808	*See* IS-M-91
5	2:54781	*See* BNL-22435
CONF-770133-		(Symposium on coal dilemma: how and where to use it, Colorado Springs, Colorado, United States of America (USA), 31 Jan-2 Feb 1977)
	2:53716	Cameron Engineers, Inc. (1976).
CONF-770210-		(A.A. advancement of science conference, Denver, Colorado, United States of America (USA), 20-25 Feb 1977)
8	2:55060	*See* BNWL-SA-6085
CONF-770211-		(ACM/IEEE symposium on design automation and microprocessors, Palo Alto, California, United States of America (USA), 24-25 Feb 1977)
6	2:55540	*See* UCLA-34P214-38
CONF-770301-		(173. national meeting of the American Chemical Society, New Orleans, Louisiana, United States of America (USA), 20-25 Mar 1977)
(Absts.)	2:54873	American Chemical Society (1977).
CONF-770303-		(Corrosion/77 NACE meeting, San Francisco, California, United States of America (USA), 14-18 Mar 1977)
2	2:54824	*See* SAND-76-8517
12	2:54822	Dep. NTIS, PC A02/MF A01
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1	2:54774	*See* LA-UR-77-397
CONF-770312-		(Annual AIME meeting, Atlanta, Georgia, United States of America (USA), Mar 1977)
2	2:53740	*See* UCRL-79145
CONF-770333-		(IITRI scanning electron microscopy symposium, Chicago, Illinois, United States of America (USA), 29 Mar 1977)
2	2:55042	*See* BNL-22258
3	2:55043	*See* BNL-22259
4	2:55044	*See* IS-M-90
6	2:54079	*See* IS-M-89
CONF-770407-		(22. national SAMPE symposium/exhibition, San Diego, California, United States of America (USA), 26-28 Apr 1977)
3	2:54857	*See* SAND-76-9082
CONF-770409-		(4. congress of the International Radiation Protection Agency, Paris, France, 24-30 Apr 1977)
8	2:55110	*See* BNL-22363
CONF-770410-		(Microcomputer '77, Oklahoma City, Oklahoma, United States of America (USA), 6-8 Apr 1977)
3	2:55504	*See* LA-UR-76-2670
CONF-770415-		(23. IES annual technical meeting and exposition, Los Angeles, California, United States of America (USA), 24-27 Apr 1977)
1	2:53642	Dep. NTIS, PC A02/MF A01
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1	2:55051	*See* UCRL-79226
2	2:55050	*See* UCRL-78737
3	2:54158	*See* LA-UR-77-574
CONF-770419-		(10. oil shale symposium, Golden, Colorado, United States of America (USA), 21-22 Apr 1977)
1	2:53963	*See* UCRL-79039
2	2:53962	*See* UCRL-79033
CONF-770440-		(American Nuclear Society topical meeting on energy and mineral recovery research, Golden, Colorado, United States of America (USA), 12-14 Apr 1977)
3	2:54189	*See* LA-UR-77-828
5	2:53626	*See* UCRL-79114
CONF-770516-		(Conference on waste heat management and utilization, Miami Beach, Florida, United States of America (USA), 9-11 May 1977)
1	2:54218	*See* K/CSD/INF-77/1
8	2:55106	*See* BNWL-SA-6222
CONF-770531-		(Meeting of the Electrochemical Society, Philadelphia, Pennsylvania, United States of America (USA), 8-13 May 1977)
2	2:54722	Dep. NTIS, PC A02/MF A01
CONF-770535-		(Society for Experimental Stress Analysis meeting, Dallas, Texas, United States of America (USA), 15-20 May 1977)
1	2:55045	*See* K/TL-670
CONF-770537-		(7. symposium on thermophysical properties, Gaithersburg, Maryland, United States of America (USA), 10-12 May 1977)
7	2:54114	*See* SAND-76-9104C
CONF-770539-		(American Wind Energy Association meeting, Boulder, Colorado, United States of America (USA), 13 May 1977)
1	2:54212	*See* SAND-77-0696C
CONF-770548-		(Annual conference on controlled fusion theory, San Diego, California, United States of America (USA), 4-6 May 1977)
1	2:55393	*See* UCRL-79377
CONF-770554-		(Conference on the plutonium fuel recycle, Miami, Florida, United States of America (USA), 2-4 May 1977)
2	2:54286	*See* BNWL-SA-6017
CONF-770557-		(4. international clean air congress, Tokyo, Japan, 16-20 May 1977)
1	2:55067	*See* LBL-5918
CONF-770567-		(Conference on lasers for isotope separation, Albuquerque, New Mexico, United States of America (USA), 17-19 May 1977)
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CONF-770569-		(Geothermal Resources Council, San Diego, California, United States of America (USA), 9-11 May 1977)
1	2:54169	*See* LBL-6303
CONF-770608-		(3. west coast statistical mechanics conference, San Jose, California, United States of America (USA), 14 Jun 1977)
1	2:54895	*See* UCRL-79374
CONF-770609-		(SPE international symposium on oilfield and geothermal chemistry, San Diego, California, United States of America (USA), 27-29 Jun 1977)
1	2:54199	*See* UCRL-79013(Pt.1)
3	2:54184	*See* UCRL-79043
CONF-770610-		(14. ACM-IEEE design automation conference, New Orleans, Louisiana, United States of America (USA), 20-22 Jun 1977)
2	2:55014	*See* UCRL-78932(Rev.1)
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1	2:54448	Dep. NTIS, PC A02/MF A01
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1	2:55475	*See* BNL-22667
CONF-770619-	(International symposium on computer methods for partial differential equations, Bethlehem, Pennsylvania, United States of America (USA), 22-24 Jun 1977)	
1	2:55541	*See* UCRL-79316
2	2:55542	*See* UCRL-79328(Pt.2)
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1	2:55046	*See* SAND-77-0290C
CONF-770626-	(18. annual symposium of the Society of Professional Well Log Analysts, Houston, Texas, United States of America (USA), 5-8 Jun 1977)	
1	2:55053	*See* UCRL-78875
CONF-770635-	(Conference on the standardization of safety and performance tests for energetic materials, Dover, New Jersey, United States of America (USA), 21-23 Jun 1977)	
1	2:55054	*See* SAND-77-0416C
CONF-770645-	(4. Rochester conference on coherence and quantum optics, Rochester, New York, United States of America (USA), 8-10 Jun 1977)	
1	2:55258	Dep. NTIS, PC A02/MF A01
CONF-770652-	(3. annual underground coal conversion symposium, Fallen Leaf Lake, California, United States of America (USA), 6-9 Jun 1977)	
2	2:53626	*See* UCRL-79114
CONF-770656-	(Annual meeting of the Institute of Nuclear Materials Management, Washington, District of Columbia, United States of America (USA), 29 Jun-1 Jul 1977)	
2	2:54076	*See* UCRL-79216
10	2:54072	*See* SAND-77-0996C
15	2:54071	*See* LA-UR-77-1306
CONF-770706-	(6. AIRAPT international high-pressure conference, Boulder, Colorado, United States of America (USA), 25-29 Jul 1977)	
1	2:53982	*See* LA-UR-77-1005
CONF-770713-	(3. international conference on laser spectroscopy, Jackson Hole, Wyoming, United States of America (USA), 4-8 Jul 1977)	
1	2:55241	Dep. NTIS, PC A02/MF A01
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1	2:55040	*See* SAND-77-0171C
2	2:55041	*See* SAND-77-0371C
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1	2:53973	*See* UCRL-79630
CONF-770801-	(Cryogenic engineering conference, Boulder, Colorado, United States of America (USA), 2-5 Aug 1977)	
1	2:55493	*See* UCRL-78865
CONF-770802-	(National heat transfer conference, Atlantic City, New Jersey, United States of America (USA), 15-17 Aug 1977)	
5	2:54605	American Society of Mechanical Engineers (1977). $3.00
CONF-770804-	(12. intersociety energy conversion engineering conference, Washington, District of Columbia, United States of America (USA), 28 Aug-2 Sep 1977)	
6	2:54190	*See* LA-UR-77-1298
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4	2:54520	*See* SAND-76-9311
5	2:54584	*See* LA-UR-77-1135
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4	2:54950	*See* Y/EN-123
CONF-770904-	(TDFM group meeting on heat fluid flow in water reactor safety, Manchester, United Kingdom of Great Britain and Northern Ireland (UK), 13-15 Sep 1977)	
1	2:54591	*See* UNI-SA-38
3	2:55004	*See* BNL-NUREG-22904
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